Marine Environmental Data Service

Computer Plotting Routines for the Bay of Fundy Tidal Power Project

J.R. Keeley

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Computer Plotting Routines for the Bay of Fundy Tidal Power Project

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DEPARTMENT OF FISHERIES AND THE ENVIRONMENT
OTTAWA, CANADA

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ABSTRACT

This technical report contains source listings, documentation and sample outputs of the plotting routines written to display the results of a numerical model of the Bay of Fundy prepared for the Bay of Fundy Tidal Power Project.

RÉSUMÉ

Ce rapport technique comprend les listes des programmes, la documentation et des échantillons des sorties des routines de traçage automatisé écrites pour présenter les résultats du modéle numérique de la baie de Fundy préparé pour ''the Bay of Fundy Tidal Power Project''.

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INTRODUCTION

The programs and documentation contained in this technical report have been prepared under contract to the Bay of Fundy Tidal Power Project. They have been used by Dr. D.A. Greenberg to display the results of a numerical model.

The programs are all written in FORTRAN and were run on a CDC CYBER74 computer in Ottawa with SCOPE 3.4 as the operating system.

The documentation has been divided into sections. The first two deal with basically one program each, and variations to them. Because of their complexity, a detailed documentation is provided. In the first section two variations of the same basic program have been fully documented and illustrated because a listing of all the required changes needed to transform one to the other was considered to be too disruptive to the easy understanding of the program.

The third section consists of several small programs needed for simple and specific data representation. Because of this, their general applicability is limited but they have been included for the sake of completeness. Documentation for each of these consists of a general description of the program, followed by a source listing with comments included, and a sample plot.

1.0 CONTOUR PLOTS

All the programs contained in this section make use of subroutines to plot the desired grid combinations and the contouring subroutine. There are two basic types of programs in this section. One type, dealt with in the first two sub-sections, contours a single set of values of a parameter within the desired grid combinations. The second type, explained in the remaining two sub-sections, draws two sets of contours on the same grid combinations. For the sake of completeness, full source listings for both types have been included in the appendices. Programs constituting variations on these two types are also described but in less detail. Only the changed portions of the source listing are included for these.

Nearly all of the programs and input data were stored on disc or tape. The names of the files on which they are stored are included since these are mentioned in the listings of control cards which are contained in the appendices.

Figures, illustrating the plots produced by the programs in the section, follow the description of the programs. A figure of each basic plot type and the variations to these are included.

1.1 ENERGY AND FRICTIONAL DISSIPATION

1.1.1 General Description

The program to contour values of the mean potential energy, mean kinetic energy and mean frictional dissipation is stored on file BKBFNRGX. The plots are made in any sequential combination of grids. Input for this program must first be calculated by the program stored on file BKENERGYX. This program is almost identical to Greenberg's DGENERGY; (personal communication) the only difference between the two is that BKENERGYX writes the output on a scratch tape besides listing it on the printer. It is this tape that serves as input for BKBFNRGX. This is all accomplished in one step by running the programs sequentially. The control cards to do this are stored on file BKJENERGYX. A listing of BKJENERGYX and BKBFNRGX is included in the documentation (see Appendix A).

The present form of the program plots first the potential energy, then the kinetic energy and finally the frictional dissipation. Plots of the grid combination 54321 are about 40 inches long and 25 inches high for a plot scale factor of 1.00.

The outline of each grid is plotted before contouring is done. The codes for the grid outlines are contained on file BRBFGRIDX. Appendix B contains a listing of these codes.

Contouring is done in one grid before proceeding to subsequent grids. On moving to the next grid, the plot origin is shifted to the origin of the grid. Should it be desirable to make a movie of the contour lines it would be necessary to alter this aspect in the same way the current vector plotting program was altered so that the whole plot is made with respect to a single plotter origin.

The actual contouring sequence deals with only four values at a time. The values are specified at four corners of a grid unit. Contours are drawn under the restriction that they may not cross a shoreline. The shoreline is coded in array IEDGE; stored as file BKNRGEDGEX. The coding is listed and explained in appendix C.

Contouring proceeds by checking all grid units, one row at a time in a single column for the designated contours before moving to the next column. This means that any grid unit need only be checked once to contour the whole grid. However, because the program does not follow a contour, the labelling of

contours is more difficult. At present, each contour passing through every 4th i,j in grids 5 and 4 is labelled. In grids 3, 2 and 1 each contour through every 6th i,j is labelled.

In order to plot barrier cases, the coding of the shoreline as well as the grid outlines must be altered. The various alterations required for the different barrier cases are listed in appendices B and C.

a) Program BFCNRG

This is the program which directs the proceedings of the contouring. All required input, except the coding of the shoreline, is read here. First a grid outline is plotted and then that grid is contoured before proceeding to a new grid. The routine NEWPEN(n) allows the grids to be drawn by one pen and the contours to be drawn with another.

The input data to be contoured for all grids always contains at least a single row of zeros at the open grid boundaries. There is no overlap of values between grids. Because of this, and that the mesh sizes change from one grid to another, it is necessary to interpolate values to allow smooth contouring between grids. A linear scheme is used for these interpolations. Appendix D illustrates and explains the interpolation schemes across all the open grid boundaries. Extrapolations are necessary for the seaward boundaries of grid 5. This is also explained in appendix D.

Subroutine CELLIJ has 2 entry points. The entry through the subroutine statement is used only once to read in the shoreline codes. Thereafter, the second entry point, CELL, is used.

Once the full plot has been made, the appropriate labels are plotted and the program stops.

b) Subroutines GRID1, GRID2, GRID3, GRID4, GRID5

The only task of these subroutines is to direct the plotting of the appropriate grid. First the position of the local origin with respect to the plot origin is calculated and stored. The first plotter instruction moves the origin from the last origin to the local origin for the grid to be plotted. Scaling factors appropriate to the grids are also calculated.

c) Subroutine GRDPLOT

This is the subroutine that plots the grid outline. The appropriate coordinates and pen instructions are obtained from array IGRD. Scale factors and the local origin are supplied by the calling subroutine.

d) Subroutine ROTATE

This subroutine is necessary to calculate the coordinates of points for the plotter. It serves two functions. Grid 1 is rotated by 45° with respect to the horizontal and, therefore, x,y coordinates from grid 1 with respect to the grid origin are linear combinations of the x,y coordinates with respect to the plotter origin. This subroutine changes the coordinates with respect to the local origin to coordinates with respect to the plotter origin.

The second function is related to the first but handles only grids 5, 4, 3 and 2. The coordinates of each grid are measured with respect to the grid origins and happen to be labelled according to a left handed system. Thus, x increases vertically downwards and y increases horizontally to the left. This is in contrast to the plotters coordinate system having x increasing horizontally to the right and y increasing vertically upwards. The contouring segment of the program deals with coordinates with respect to the local origin. When it comes time to plot the contours or grid outlines subroutine ROTATE converts to the plotter's coordinate system.

e) Subroutine CELLIJ

This subroutine sets up the variables and codes appropriate for a single grid unit in preparation for the actual contouring subroutine. The coding on the four corners is checked to ensure that no more than one corner lies on land. If more than one corner lies on land the grid unit is not contoured.

f) Subroutine TRACK

This subroutine calculates the positions of the contours on the sides of a single grid unit and then joins them up appropriately. The sides of a single grid unit are coded 1 = top, 2 = right side, 3 = bottom, 4 = left side.

The first section of the subroutine locates the position of the contour on all sides applicable. If one corner of a grid unit lies on land, the two adjacent sides are not searched for contour intersections. Once all intersections of the contour with the sides of the grid unit are found control transfers to the second section of the subroutine.

The second section is concerned with determining if the intersection points on the sides of the grid unit may be joined. Restrictions on the joining of two intersection points are supplied by the shoreline code array IEDGE. Two intersection points may not be joined if the line joining them would pass through a shoreline. If it is admissible to join more than two intersection points the closest two are joined under the following rules of priority with highest priority first:

join side	1 to 2
	1 to 3
	1 to 4
	2 to 3
	2 to 4
	3 to 4

When there are 4 admissible intersection points two contour lines can be drawn in a single grid unit. The first contour line follows the above rules of priority in joining the two closest. Then, the remaining two intersection points are joined.

After a grid unit has been contoured a check is made if the line is to be labelled. Control then returns to the calling subroutine.

All values to be contoured are dealt with in a single grid unit before proceeding to the next grid unit.

1.1.2 Inputs Required

The required inputs to be supplied to this program are either read from the input file or are contained on disc. The names for the files which are listed here are the logical file names by which they are identified by the program.

a) TAPE1: This consists of two parts. The first part contains the five arrays specifying the coordinates of the grid outlines with respect to each grid's local origin. These values are stored in the array IGRD. The second part consists of the 5 arrays of coordinates, again with respect to their local origins, specifying the regions covered by water. The values are stored in the array IBNDRY. For the no barrier case, the data for TAPE1 are stored on file BRBFGRIDX. For the barrier cases, this file is altered appropriately (see appendix B) and stored as file BRBFGRIDX1.

b) TAPE2: This is the array specifying the shoreline code for each grid. The codes for the no barrier case are stored as file BKNRGEDGEX. TAPE2 is read in subroutine CELLIJ and values are stored in the array IEDGE. For the different barrier cases, the file must be altered (see appendix C) and this altered set of codes is stored as file BKNRGEDGEX1.

c) TAPE3: This is the data on a scratch disk file created by the program BKENERGYX. It contains values for the mean potential energy/cm^2 for every point in all five grids. Following values for the potential energy are all values for the mean kinetic energy/cm^2 at every point in the grids and then values for the mean frictional dissipation/cm^2/sec. The data on TAPE3 is stored in format free form and read into the arrays Z1 to Z5 for grids 1 to 5. The reading and contouring of the potential energy is completed before proceeding to the kinetic energy. The same applies to the kinetic energy and frictional dissipation.

These data for TAPE3 are calculated from the appropriate values of tidal elevation and currents. Thus, for each barrier case the input tape to calculate the potential and kinetic energy and frictional dissipation will change.

d) TAPE10: All output for the calcomp plotter is written onto TAPE10 and saved on a magnetic tape.

e) INPUT: Values for BASESC, IWNTGRD and FAC are read from input first. Next the barrier case label is read. Next is read the number of values of potential energy to be contoured and the contour values. Similar numbers for the kinetic energy case and frictional dissipation follow. The appropriate formats can be found from the program listing and sample input data in the listing of BKJENERGYX included with this documentation.

1.1.3 Output Generated

Output from BKENERGYX lists the values of potential energy, kinetic energy and frictional dissipation for all five grids. This is the data on TAPE3 which is to be contoured.

Output from program BFCNRG echo prints the values read for BASESC, IWNTGRD and FAC. Also printed are the values being contoured in plot 1, the potential energy, plot 2, the kinetic energy and plot 3, the frictional dissipation. Following this is an echo print of the label on the plot.

1.1.4 Arrays

a) In COMMON

i) IGRD(I,J,K): is the array of coordinates defining the outlines of the grids.

K is the grid number

J is a sequential index of the coordinates needed to define the grid outline

I = 1 is a pen instruction

I = 2,3 is the x,y coordinates of the point on the grid outline.

ii) NPTS(K): is the array containing the number of coordinate pairs to draw a grid.

K is the grid number

NPTS(K) equals the maximum value of J for grid K in IGRD.

iii) IWNTGRD(K): a 5 element array specifying which grids are to be plotted. Values for IWNTGRD must be sequential and in decreasing order. If all 5 grids are not wanted, IWNTGRD should be zero filled to 5 elements.

iv) Z(I,J): A dummy array to contain the values for each grid as it is to be contoured. Values in Z(I,J) change from grid to grid. The dimensions of array Z sometimes exceed the corresponding Zi array because of the necessity to interpolate values between grids.

v) IB(K): an array of 4 elements holding the shoreline codes for the 4 corners of the grid unit in which contours are to be drawn.

vi) CONTOUR(K): the array containing the values to be contoured in the grids. Values stored in CONTOUR are read each time a new data set is to be contoured.

vii) IST(K): the x dimension for grid number K of the array IEDGE to be read.

viii) IND(K): the y dimension for grid number K of the array IEDGE to be read.

ix) IEDGE(I,J,K): the array of shoreline codes for grid K at coordinates I,J.

b) In BFCNRG

i) Z1(I,J) to Z5(I,J): arrays holding values for the mean potential energy, then mean kinetic energy, then frictional dissipation at the coordinate I,J. Z1 corresponds to grid 1, etc. It is these values for which the contouring takes place.

ii) BUFF(I): an array specifying the size of the buffer for the plotter.

iii) DIV(I): an array of 3 elements containing factors by which the 3 data sets are to be scaled before contouring is attempted. In the present form of the program all the factors are equal to 1.0.

c) In TRACK

i) ISET(I): an array of four elements, one for each corner of the grid unit in which contours are to be drawn. ISET(I) can take on the value 1 if corner I lies on land (i.e. code = 4) or 0 if corner I is not on land (codes 3, 2, 1 or 0). If ISET(I) = 1 the two adjacent sides to corner I are not inspected for intersections of the value being contoured with the side of the grid unit.

ii) EX(I), EY(I): arrays of four elements specifying the x and y coordinates respectively of the intersection points of the contour being drawn on the side, I, of the grid unit. By default EX(I), EY(I) are initially set equal to the I,J coordinates of the grid unit to be contoured.

1.1.5 Variables

a) In COMMON

i) XUP, YUP: these are the x and y coordinates of the plot origin with respect to the local origin.

ii) SCALE: this is the factor by which a grid unit is reduced from the size of a grid unit of the first grid plotted. In all cases SCALE = BASESC for the first grid plotted.

iii) NDATA: an integer specifying which data set is being contoured. NDATA = 1 is for the potential energy, = 2 for the kinetic energy, = 3 for the frictional dissipation.

b) In BFCNRG

i) ND: a variable set equal to NDATA and used to insure the correct labelling of each of the three plots.

ii) IGRDNO: a dummy variable to read the grid number from TAPE1.

iii) FAC: this specifies the scaling factor for the whole plot. Thus, FAC*BASESC is the size of the largest grid unit to be plotted. FAC is varied for the different combinations of grids to be plotted. For the combination 54321 FAC = 1.4 and for 32100 FAC = 1.0.

iv) BASESC: is the size in inches of a side of the largest grid cell to be plotted. At present BASESC is typically set equal to one with the size of the whole plot being altered by FAC.

v) ALAB: the label to be written on the plot to identify the barrier case being plotted. ALAB must be 10 characters or less.

vi) NVC: a variable read from input specifying the number of values to be contoured in the data set under consideration. NVC typically varies with the data set in question.

vii) FRA: a dummy variable set equal to the appropriate value of the array DIV for the data set under consideration. FRA scales all the data before contouring is attempted.

viii) SCA: a variable, scaled by FAC, to ensure that plots are spaced far enough apart so that they do not overlap.

ix) SC: a variable to ensure that the plotter pen is at the bottom of the plot paper at the start of each plot.

x) HX: the x coordinate with respect to the plot origin at which all labelling begins.

xi) HY: the y coordinate with respect to the plot origin at which the main plot title begins.

xii) HX1, HX2, HX3: x coordinates measured relative to HX at which subsequent labels begin.

xiii) HY1, HY2: y coordinates measured relative to HY at which subsequent labels begin.

c) In GRID4, GRID3, GRID2, GRID1

i) X,Y: the x,y coordinates of the origin of the grid under consideration, with respect to the last origin.

d) In GRDPLOT

i) XX,YY: the x,y coordinates, with respect to the local grid origin, of the points on the grid outline to be plotted.

e) In TRACK

i) X,Y: these variables have two uses:

1) X,Y are initially set equal to the x,y coordinates of the centre of the grid unit under consideration.

2) after admissible intersection points have been determined X,Y are set equal to the x,y coordinates of one of the admissible end points of a contour line.

ii) KGRD: an integer specifying the grid which is currently being contoured.

iii) CNTR: the variable specifying the value being contoured in the grid unit under consideration.

iv) DIST2, DIST3, DIST4: variables used to establish the distance, in grid units, between the intersection point on the side under consideration and the intersection point on side 2, 3 or 4. If there is no intersection point on side i or if the line joining the point under consideration and the point on side i intersects a shoreline DISTi is set equal to 10. Otherwise, DISTi is the actual distance in grid units between the point under consideration and the point on side i. If DISTi = 10. the contour line is not drawn. DISTi is used to determine the two closest intersection points to be joined following the priorities mentioned in the description of subroutine TRACK.

v) D1, D2: these variables have two uses:

1) in the first section of this subroutine D1 and D2 are the differences between the value being contoured and the values of the data at the two corners of the grid unit at either end of the side under consideration.

2) in the second section D1, D2 are the differences between the position of the intersection point on sides 1, 2 and the midpoint on sides 1 or 2.

vi) D3, D4: variables used in the second section of the subroutine similar to D1, D2 as described above in v2.

vii) DD1, DD2, DD3, DD4: these variables are used in the pairs 1, 3 or 2, 4. DDi is the distance between the intersection point on side i and one end of side i. DDi + 2 is the distance between the intersection point on side i + 2 and the end on side i + 2 diagonally opposite that chosen on side i.

viii) XX, YY: the x and y coordinates of the other end point of an admissible contour line. Thus, X,Y (mentioned in i2) and XX, YY are always joined.

ix) X1, Y1, X2, Y2: the x and y coordinates of the other intersection points calculated. These points are joined only if they are fully admissible. This contour line would then be the second one in a grid unit as was described in the description of subroutine TRACK.

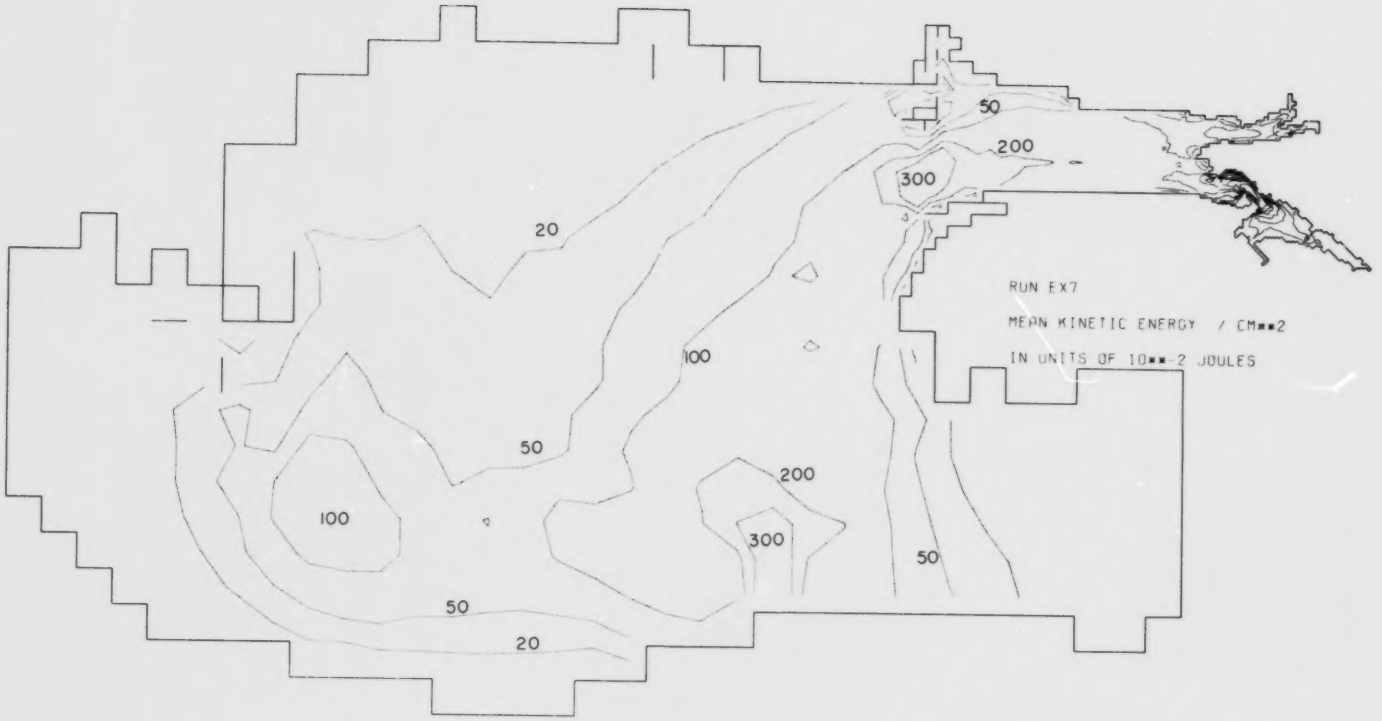

Figure 1

Sample plot of the contouring of the potential energy, kinetic energy and frictional dissipation.

f) In CELLIJ

i) IGRDNO: a dummy variable to read the grid number from TAPE2.

ii) IEND, JEND: dummy integer variables set equal to the x,y dimensions of the array of shore codes for each grid.

iii) FMT: a variable used to encode IEND into a format statement.

iv) CNTR: the current value to be contoured. CNTR takes on all values of CONTOUR and all contours are drawn in one grid unit before proceeding to the next grid unit.

g) In ROTATE

i) XX, YY, X,Y: the values of the x,y coordinates of the two end points of the contour line to be drawn. As control moves into subroutine ROTATE these are all measured relative to the local grid origin. The subroutine transforms these to coordinates with respect to the plot origin and returns control to TRACK so that the contour line may be drawn.

ii) X1, Y1, X2, Y2: dummy variables used in the transformation of XX, YY, X,Y from coordinates with respect to the grid origin to coordinates with respect to the plot origin.

1.2 VARIATIONS ON ENERGY AND FRICTIONAL DISSIPATION

The programs contained in this sub-section are those which are readily derivable from the program described in 1.1. In most cases, only the changes necessary to produce the desired plot are made. Thus, there exist variables and/or portions of the program which serve no useful purpose to produce the plot. The required changes to the source listing for the program in 1.1 are described. Also included are the portions of the source listing in which the changes have been made. Line numbers, consistent with those of the program in 1.1, are retained to make comparisons easier.

1.2.1 Mixing Parameters

General Description:

This program is a slight modification of the energy contouring program. The mixing parameter is obtained from the frictional dissipation. Thus, as before, program BKENERGYX is used to calculate the potential energy and kinetic energy and then the mixing parameter rather than the frictional dissipation. Again all three quantities are output onto tape but only the third is contoured.

Input arrays are the same as before. An alteration to BKJENERGYX is required. Input data for BKENERGYX is the same as for the energy contouring program for the extended model. Note that appropriate changes (as listed for the extended model energy contouring program) to BRBFGRIDX and BKNRGEDGEX are required for different barrier cases.

I. BKBFNRGX

1. PROGRAM BFCNRG

a) line 43: this ensures that only the mixing parameter is plotted.

b) line 101 and 185: these lines ensure the shoreline code array is read in for the first grid to be contoured. If grid 4 were the first grid a similar charge would have to be made in line 139.

c) lines 280 to 285: changes to label the plot appropriately.

1.2.2 Maximum Stress

The program to calculate the maximum u and v velocities over a tidal cycle at each grid point is called UMAX. The source listing of this follows. Values of ful maximum are printed and output on a scratch tape for the contouring program.

The contouring program used is a variation of the mixing parameter program. A listing of the sections of the source program which have been changed follows. The changes are only to the labels of the plot and therefore it is quite evident where they fit into the mixing parameter program.

1.3 TIDAL AMPLITUDE AND PHASE

The program contained in this subsection is of the 2 nd. type referred to in the introduction to this section. Again, file names are included since they are referred to in the required control cards to run the program. Some of the necessary inputs are the same as those for the program in 1.1 and, hence, the appropriate appendices are referenced.

This program differs from that described in 1.1 basically in the main program and in the contouring subroutine. However, because the changes are extensive, a complete source listing has been included so that continual references to the program of 1.1 need not be made.

1.3.1 General Description

The program to contour values of the amplitude and phase of the M2 tide is stored on file BKBFAMPHASEX. The plots are made in any sequential combination of grids. Input for this program must first be calculated by the program stored on file BKFSANAL. This program is almost identical to Greenberg's DGFSANAL. The only difference between the two is that BKFSANAL writes the output on a scratch disk file besides listing it on the printer. It is this file that serves as input for BKBFAMPHASEX. This is all accomplished in one step by running the program sequentially. The control cards to do this are stored on file BKJAMPHASEX. Listings of BKJAMPHASEX and BKBFAMPHASEX are included in the documentation in appendix E.

The present form of the program plots the contours of amplitude and phase on the same grid outline. The two different contours are distinguished by two different pens. The grid combination of 54321 is presently plotted with a scale factor of 1.0 but this could be increased to 1.4 to take full advantage of the width of the plot paper.

The plotting sequence begins by drawing a grid outline and plotting the contours of amplitude in that grid. The next grid outline is drawn and the amplitude contoured in it. This continues until all grid outlines are drawn and the amplitude has been contoured in all grids. Then, the phase is contoured beginning with the first grid and proceeding to the last. On moving to another grid, the plot origin is shifted from its previous position to the origin of the grid to be plotted and/or contoured. Should it be desireable to make

Table 1

Modifications to Appendix A required to plot the mixing parameter.

```
******* INSERT AFTER LINE 42 *******                                    I
       IF(NDATA.LT.3) GO TO 779                                        I
-                                                                      -
      IF(NDATA.NE.3) GO TO 52                                  000101
-                                                                      -
      IF(NDATA.NE.3) GO TO 32                                  000185
-                                                                      -
200   CALL SYMBOL(HX,HY,.28,10HMEAN STRAT,0.,10)               000280
      CALL SYMBOL(HX1,HY,.28,10HIFICATION ,0.,10)              000281
      CALL SYMBOL(HX,HY2,.28,10HIN UNITS O,0.,10)              000282
      CALL SYMBOL(HX1,HY2,.28,10HF 10**2 SE,0.,10)             000283
      CALL SYMBOL(HX2,HY2,.28,10HC*CM**3/ER,0.,10)             000284
      CALL SYMBOL(HX3,HY2,.28,1HG,0.,1)                        000285
```

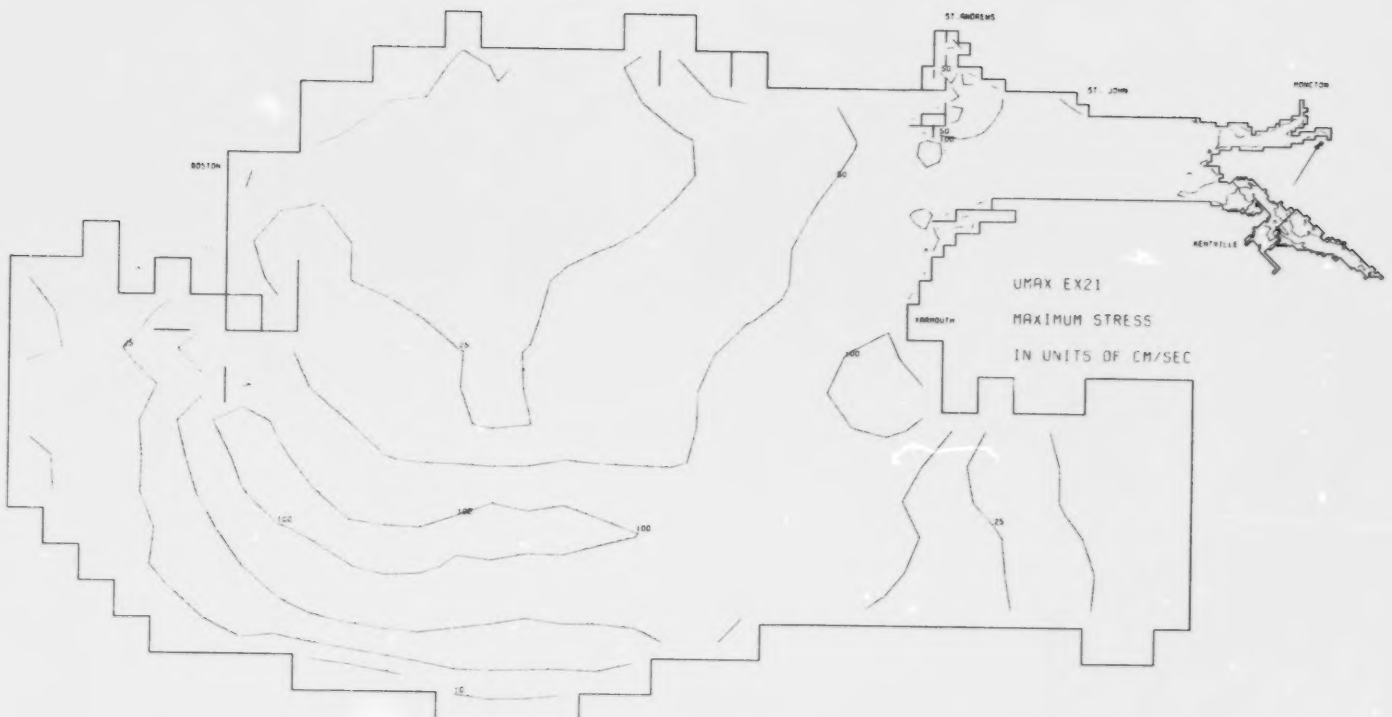

Figure 2

Sample plot of the contours of maximum stress.

Table 2

Modifications to Appendix A required to plot the maximum stress.

```
      PROGRAM UMAX(INPUT,OUTPUT,TAPE2,TAPE3,TAPE4)                          000001
      DIMENSION U1(29,65),U2(15,28),U3(25,17),U4(25,24),U5(22,33)           000002
      DIMENSION V1(29,65),V2(15,28),V3(25,17),V4(25,24),V5(22,33)           000003
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)           000004
      DIMENSION UMX1(29,65),UMX2(15,28),UMX3(25,17),UMX4(25,24),UMX5(22,    000005
     +33)                                                                   000006
      DIMENSION IE1(29,65),IE2(15,28),IE3(25,18),IE4(25,25),IE5(22,33)      000007
C                                                                           000008
C        ZERO ALL THE ARRAYS                                                000009
      DO 101 I=1,29                                                         000010
      DO 101 J=1,65                                                         000011
101   UMX1(I,J)=0.                                                          000012
      DO 102 I=1,15                                                         000013
      DO 102 J=1,28                                                         000014
102   UMX2(I,J)=0.                                                          000015
      DO 103 I=1,25                                                         000016
      DO 103 J=1,18                                                         000017
103   UMX3(I,J)=0.                                                          000018
      DO 104 I=1,25                                                         000019
      DO 104 J=1,25                                                         000020
104   UMX4(I,J)=0.                                                          000021
      DO 105 I=1,22                                                         000022
      DO 105 J=1,33                                                         000023
105   UMX5(I,J)=0.                                                          000024
C                                                                           000025
C        READ THE SHORELINE CODE ARRAY                                      000026
      READ(2,1000) HEADER,IX,IY                                             000027
1000  FORMAT(A6,2I3)                                                        000028
      READ(2,1001)((IE1(I,J),I=1,IX),J=1,IY)                                000029
1001  FORMAT(29I1)                                                          000030
      READ(2,1000) HEADER,IX,IY                                             000031
      READ(2,1002)((IE2(I,J),I=1,IX),J=1,IY)                                000032
1002  FORMAT(15I1)                                                          000033
      READ(2,1000) HEADER,IX,IY                                             000034
      READ(2,1003)((IE3(I,J),I=1,IX),J=1,IY)                                000035
1003  FORMAT(25I1)                                                          000036
      READ(2,1000) HEADER,IX,IY                                             000037
      READ(2,1004)((IE4(I,J),I=1,IX),J=1,IY)                                000038
1004  FORMAT(25I1)                                                          000039
      READ(2,1000) HEADER,IX,IY                                             000040
      READ(2,1005)((IE5(I,J),I=1,IX),J=1,IY)                                000041
1005  FORMAT(22I1)                                                          000042
      DO 100 II=1,48                                                        000043
C                                                                           000044
C        READ THE U V DATA                                                  000045
      READ(4)                                                               000046
      READ(4) U1,U2,U3,U4,U5                                                000047
      READ(4) V1,V2,V3,V4,V5                                                000048
C                                                                           000049
C        FIND THE MAXIMUM U V VALUES OVER A TIDAL CYCLE                     000050
      DO 111 I=1,29                                                         000051
      DO 111 J=1,65                                                         000052
      IF(IE1(I,J).EQ.4) GO TO 111                                           000053
      P=(U1(I,J)+U1(I-1,J))*.5                                              000054
      Q=(V1(I,J)+V1(I,J-1))*.5                                              000055
      Z1(I,J)=SQRT(P**2+Q**2)                                               000056
111   UMX1(I,J)=AMAX1(UMX1(I,J),Z1(I,J))                                    000057
      DO 112 I=1,15                                                         000058
      DO 112 J=1,28                                                         000059
      IF(IE2(I,J).EQ.4) GO TO 112                                           000060
      P=(U2(I,J)+U2(I-1,J))*.5                                              000061
      Q=(V2(I,J)+V2(I,J-1))*.5                                              000062
      Z2(I,J)=SQRT(P**2+Q**2)                                               000063
112   UMX2(I,J)=AMAX1(UMX2(I,J),Z2(I,J))                                    000064
      DO 113 I=1,25                                                         000065
      DO 113 J=1,17                                                         000066
      IF(IE3(I,J).EQ.4) GO TO 113                                           000067
      P=(U3(I,J)+U3(I-1,J))*.5                                              000068
      Q=(V3(I,J)+V3(I,J-1))*.5                                              000069
      Z3(I,J)=SQRT(P**2+Q**2)                                               000070
113   UMX3(I,J)=AMAX1(UMX3(I,J),Z3(I,J))                                    000071
      DO 114 I=1,25                                                         000072
      DO 114 J=1,24                                                         000073
      IF(IE4(I,J).EQ.4) GO TO 114                                           000074
      P=(U4(I,J)+U4(I-1,J))*.5                                              000075
      Q=(V4(I,J)+V4(I,J-1))*.5                                              000076
      Z4(I,J)=SQRT(P**2+Q**2)                                               000077
114   UMX4(I,J)=AMAX1(UMX4(I,J),Z4(I,J))                                    000078
      DO 115 I=1,22                                                         000079
      DO 115 J=1,33                                                         000080
      IF(IE5(I,J).EQ.4) GO TO 115                                           000081
      P=(U5(I,J)+U5(I-1,J))*.5                                              000082
      Q=(V5(I,J)+V5(I,J-1))*.5                                              000083
      Z5(I,J)=SQRT(P**2+Q**2)                                               000084
115   UMX5(I,J)=AMAX1(UMX5(I,J),Z5(I,J))                                    000085
100   CONTINUE                                                              000086
C                                                                           000087
C        WRITE OUT THE MAXIMUM STRESS                                       000088
      WRITE(3) UMX1,UMX2,UMX3,UMX4,UMX5                                     000089
      WRITE(3) UMX1,UMX2,UMX3,UMX4,UMX5                                     000090
      WRITE(3) UMX1,UMX2,UMX3,UMX4,UMX5                                     000091
      PRINT 500,((UMX1(I,J),I=1,25),J=1,65)                                 000092
500   FORMAT(5X,25F5.0/)                                                    000093
      PRINT 500,((UMX1(I,J),I=5,29),J=29,47)                                000094
      PRINT 501,((UMX2(I,J),I=1,15),J=1,28)                                 000095
501   FORMAT(5X,15F5.0/)                                                    000096
      PRINT 500,((UMX3(I,J),I=1,25),J=1,17)                                 000097
      PRINT 500,((UMX4(I,J),I=1,25),J=1,24)                                 000098
      PRINT 502,((UMX5(I,J),I=1,22),J=1,33)                                 000099
502   FORMAT(5X,22F5.0/)                                                    000100
      STOP                                                                  000101
      END                                                                   000102
```

```
******* INSERT AFTER LINE 42 *******                                    I
      IF(NDATA.LT.3) GO TO 779                                          I
-                                                                       -
      IF(NDATA.NE.3) GO TO 52                                          000101
-                                                                       -
      IF(NDATA.NE.3) GO TO 32                                          000185
-                                                                       -
200   CALL SYMBOL(HX,HY,.28,10HMAXIMUM ST,0.,10)                       000280
      CALL SYMBOL(HX1,HY,.28,4HRESS,0.,4)                              000281
      CALL SYMBOL(HX,HY2,.28,10HIN UNITS O,0.,10)                      000282
      CALL SYMBOL(HX1,HY2,.28,8HF CM/SEC,0.,8)                         000283
-                                                                       -
******* DELETE LINE 279 *******                                         D
-                                                                       -
******* DELETE LINES 284 TO 300 *******                                 D
```

a movie of the contour lines it would be necessary to alter this aspect in the same way the current vector plotting program was altered so that the whole plot is made with respect to a single plotter origin.

The actual contouring segment deals with only four values at a time. The values are specified at the four corners of a grid unit. Contours are drawn with the restriction that they may not cross a shoreline. The shoreline is coded in array IEDGE; the coding is listed and explained in appendix C.

Contouring proceeds by checking all grid units, one row at a time in a single column, for the designated contours before moving to the next column. This means that any grid unit need only be checked once to contour the whole grid. However, because the program does not follow a contour, the labelling of contours is more difficult. At present, all contours of phase are labelled if the contour passes through every fourth i and j in a grid. The amplitude is similarly labelled except for grid 1. There, because of drying shores contours are so close together that any labelling becomes untidy. Hence, in grid 1, the amplitude contours are not labelled.

In order to plot barrier cases the coding of the shoreline as well as the grid outlines must be altered. The various changes required for the different barrier cases are listed in appendices B and C.

a) Program BFCAP

This is the portion which directs the proceedings of the contouring. All required input except the coding of the shoreline is read here. First a grid outline is drawn and then the amplitude is contoured within that grid. All grids are done this way before the contours of phase are drawn. The routine NEWPEN(n) allows the grids and the two different contours to be drawn by different pens.

To ensure a smooth transition of contour lines across grid boundaries it is necessary to interpolate some values between grids. For grid boundaries 5,4 and 4,3 one extra row for 4 and 3 respe tively is added and values in that row interpolated across the grids. Appendix D illustrates and explains the interpolation schemes.

Subroutine CELLIJ has two entry points. The entry through the subroutine statement is used only once to read in the shoreline codes. Thereafter the second entry point, CELL, is used.

Once the full plot is made, the appropriate label is plotted and the program stops.

b) Subroutines GRID1, GRID2, GRID3, GRID4, GRID5

The only task of these subroutines is to direct the plotting of the appropriate grid. First the position of the local origin with respect to the plot origin is calculated and stored. The first plotter instruction moves the origin from the previous position to the local origin for the grid to be plotted and/or contoured. Scaling factors appropriate to the grids are also calculated.

c) Subroutine GRDPLOT

This is the subroutine that actually plots the grid outline. The appropriate coordinates and pen instructions are obtained from array IGRD. Scale factors and the local origin are supplied by the calling subroutine.

d) Subroutine ROTATE

This subroutine is necessary to calculate the coordinates of points for the plotter. It serves two functions. Grid1 is rotated by 45° with respect to the horizontal and, therefore, x and y coordinates from grid 1 with respect to the grid origin are linear combinations of the x and y coordinates with respect to the plotter

origin. This subroutine changes the coordinates with respect to the local origin to coordinates with respect to the plotter origin.

The second function is related to the first, but deals with only grids 5,4,3 and 2. The coordinates of each grid are measured with respect to the grid origin and happen to be labelled according to a left handed system. Thus, x increases vertically downwards and y increases horizontally to the left. This is in contrast to the plotter's coordinate system having x increasing horizontally to the right and y increasing vertically upwards. The contouring segment of the program deals with coordinates with respect to the local origin. When it comes time to plot the contours or the grid outlines this subroutine converts to the coordinate system of the plotter.

e) Subroutine CELLIJ

This subroutine sets up the variables and codes appropriate for a single grid unit in preparation for the actual contouring subroutine. The coding on the four corners is checked to ensure that no more than one corner lies on land. If more than one corner lies on land the grid unit is not contoured.

f) Subroutine TRACK

The first section of the subroutine is applicable only when contouring the phase. Because the phase is cyclic, the transition from 359° to 1° can cause problems in that all values to be contoured lie between these values. Of course, it is not desireable for all these contours to be drawn at the transition region. To circumvent this, all four phase values are checked to see if there is a difference of 180° between pairs. If there is, 360° is added to the smaller phase. This is adequate for the values normally encountered. However, problems may arise where the phase is changing very rapidly. (see appendix F).

The next section calculates the positions of the contours on the sides of a single grid unit and joins them up appropriately. The sides of a grid unit are coded 1 = top, 2 = right side, 3 = bottom, 4 = left side. If one corner of a grid unit lies on land, the two adjacent sides are not searched for contour intersections, otherwise all sides are searched for intersections of the contour. Once all intersections are found control transfers to the next section.

The final section is concerned with determining if the intersection points on the sides of the grid unit may be joined. Restrictions on the joining of two intersection points are supplied by the shoreline code array, IEDGE. Two intersection points may not be joined if the line joining them would pass through a shoreline. If it is admissible to join more than two intersection points, the closest two are joined under the following rules of priority with the highest priority first:

join side	1 to 2
	1 to 3
	1 to 4
	2 to 3
	2 to 4
	3 to 4

When there are four admissible intersection points, two contour lines can be drawn in a single grid unit. The first contour line follows the above rules of priority in joining the two closest. Then, the remaining two intersection points are joined.

After a grid unit has been contoured a check is made if the line is to be labelled. Control then returns to the calling subroutine.

All values to be contoured are dealt with in a single grid unit before proceeding to the next grid unit.

1.3.2 Inputs Required

a) TAPE1: This consists of two parts. The first part contains the five arrays specifying the coordinates of the grid outlines with respect to each grid's local origin. These values are stored in the array IGRD. The second part consists of the five arrays of coordinates, again with respect to their local origins, specifying the regions covered by water. The values are stored in the array IBNDRY. For the no barrier case, the data for TAPE1 are stored on file BRBFGRID. For the barrier cases, this file is altered appropriately (see appendix B) and stored as file BRBFGRID1.

b) TAPE2: This is the array specifying the shoreline code for each grid. The codes for the no barrier case are stored as file DGBFCEDGE. TAPE2 is read in subroutine CELLIJ and values are stored in the array IEDGE. For the different barrier cases, the file must be altered (see appendix C) and this altered set of codes is stored as file DGBFCEDGE1.

c) TAPE3: This is the data on a scratch disc file created by the program BKFSANAL. It contains values for the amplitude (in cms.) and phase (in degrees) for every point in all five grids. The data on TAPE3 is stored in format free form and read into the arrays Z1 to Z5 for grids 1 to 5 respectively.

These data for TAPE3 are calculated from the appropriate values of tidal elevation and currents. Thus, for each barrier case the input tape required to calculate the amplitude and phase will change.

d) INPUT: Values for BASESC, IWNTGRD and FAC are read from input first. Next is read the number of values of the amplitude to be contoured and the contour values. Similar input for the phase follows. Lastly comes the label for the plot. The appropriate formats can be found from the program listing and sample input data in the listing of BKJAMPHASEX included with this documentation.

1.3.3 Output Generated

a) TAPE10: All output for the calcomp plotter is written onto TAPE10 and saved on a magnetic tape.

b) Output from BKFSANAL lists the values of the amplitude and phase for all five grids. This is the data on TAPE3 which is to be contoured.

Output from program BKBFAMPHASEX echo prints the values read for BASESC, IWNTGRD and FAC. Also printed are the values being contoured in plot 1, the amplitude, and plot 2, the phase. Following this is an echo print of the plot label.

1.3.4 Array

a) In COMMON

i) IGRD(I,J,K): is the array of coordinates defining the outlines of the grids.

K is the grid number

J is a sequential index of the coordinates needed to define the grid outline

I = 1 is a pen instruction

I = 2,3 is the x,y coordinates of the point on the grid outline.

ii) NPTS(K): is the array containing the number of coordinate pairs to draw a grid.

K is the grid number

NPTS(K) equals the maximum value of J for grid K in IGRD.

iii) IWNTGRD(K): a five element array specifying which grids are to be plotted. Values for IWNTGRD must be sequential and in decreasing order. If all five grids are not to be plotted, IWNTGRD should be zero filled to five elements.

iv) Z(I,J): a dummy array to contain the values for each grid as it is to be contoured. Values in Z change from grid to grid. The dimensions of array Z sometimes exceed the corresponding Zi array because of the necessity to interpolate values between grids.

v) IB(K): an array of four elements holding the shoreline codes for the four corners of the grid unit in which contours are to be drawn.

vi) CONTOUR(K): the array containing the values to be contoured in the grids. Values stored in CONTOUR are read each time a new data set is to be contoured.

vii) IST(K): the x dimension for grid number K of the array IEDGE to be read.

viii) IND(K): the y dimension for grid number K of the array IEDGE to be read.

ix) IEDGE(I,J,K): the array of shoreline codes for grid K at coordinates I,J.

b) In BFCAP

i) Z1(I,J) to Z5(I,J): arrays holding values for the amplitude and then the phase of the M2 tide at the coordinate I,J. Z1 corresponds to grid 1, etc. It is among these values that the contouring takes place.

ii) BUFF(I): an array specifying the size of the buffer for the plotter.

iii) CONT(I,J): the array containing the values to be contoured. I = 1 amplitudes, I = 2 phases.

iv) NVC1(I): these are the number of values to be contoured for amplitude (I = 1) and phase (I = 2).

c) In TRACK

i) ISET(I): an array of four elements, one for each corner of the grid unit in which contours are to be drawn. ISET(I) can take on the value 1 if corner I lies on land (i.e. code = 4) or 0 if corner I is not on land (codes 3,2,1 or 0). If ISET(I) = 1 the two adjacent sides to corner I are not inspected for intersections of the value being contoured with the side of the grid unit.

ii) EX(I), EY(I): arrays of four elements specifying the x and y coordinates respectively of the intersection points of the contour being drawn on the side I of the grid unit. By default, EX(I), EY(I) are initially set equal to the I,J coordinates of the grid unit to be contoured.

1.3.5 Variables

a) In COMMON

i) XUP, YUP: these are the x and y coordinates of the plot origin with respect to the local origin.

ii) SCALE: this is the factor by which a grid unit is reduced from the size of a grid unit of the first grid plotted. In all cases SCALE = BASESC for the first grid plotted.

iii) IFLAG: an integer specifying which data set is being contoured. For the amplitude IFLAG = 1 and for phase IFLAG = 2.

b) In BFCAP

i) IGRDNO: a dummy variable to read the grid number from TAPE1.

ii) BASESC: is the size in inches of a side of the largest grid unit to be plotted. At present BASESC is typically set equal to 1 with the size of the whole plot being altered by FAC.

iii) FAC: this specifies the scaling factor for the whole plot. Thus FAC*BASESC is the size of the largest grid unit to be plotted. FAC is varied for the different combinations of grids to be plotted. For the combination 54321, FAC = 1.4 and for 32100, FAC = 1.0.

iv) NVC: a variable specifying the number of values to be contoured in the data set under consideration. NVC typically is different for the amplitude and the phase.

v) HX: the x coordinate with respect to the plot origin at which labelling begins.

vi) HY: the y coordinate with respect to the plot origin at which labelling begins.

vii) HX1, HX2, HX3, HY1, HY2, HY3: x and y coordinates measured relative to HX, HY at which subsequent labels begin.

viii) ALAB: the label to be written on the plot to identify the barrier case being plotted. ALAB must be 10 characters or less.

c) In GRID4, GRID3, GRID2, GRID1

i) X,Y: the x,y coordinates of the origin of the grid under consideration, with respect to the last origin.

d) In GRDPLOT

i) XX,YY: the x,y coordinates, with respect to the local grid origin, of the points on the grid outline to be plotted.

e) In TRACK

i) X,Y: these variables have two uses:

1) X,Y are initially set equal to the x,y coordinates of the center of the grid unit under consideration.

2) after admissible intersection points have been determined, X,Y is set equal to the x,y coordinates of one of the admissible end points of the contour line.

ii) DIST2, DIST3, DIST4: variables used to establish the distance, in grid units, between the intersection points on the side under consideration and the intersection point on side 2,3 or 4. If there is no intersection point on side i, or if the line joining the point under consideration and the point on side i intersects a shoreline, DISTi is set equal to 10. Otherwise DISTi is the actual distance in grid units between the point under consideration and the point on side i. If DISTi = 10 the contour line is not drawn. DISTi is used to determine the two closest intersection points to be joined following the priorities mentioned in the description of subroutine TRACK.

iii) ZE1, ZE2, ZE3, ZE4: these variables are set equal to the value of the data at the four corners of the grid unit being contoured. They are used when contouring the phase. If two corners differ by more than 180° in phase, 360° is added to the smaller of the two corners.

iv) CNTR: the variable specifying the value being contoured in the grid unit under consideration.

v) KGRD: an integer specifying the grid which is currently being contoured.

vi) D1, D2: these variables have three uses:

1) In the phase contouring portion D1 is the difference in phase between adjacent corners of a grid unit.

2) In the second part of this subroutine D1 and D2 are the differences between the value being contoured and the values of the data at the two corners of the grid unit at either end of the side under consideration.

3) In the third section D1, D2 are the differences between the position of the intersection point on sides 1 and 2 and the midpoint on sides 1 and 2.

vii) D3, D4: variables used in the third section of the subroutine similar to D1, D2 as described above in vi 3.

viii) DD1, DD2, DD3, DD4: these variables are used in the pairs 1,3 or 2,4. DDi is the distance between the intersection point on side i and one end of side i. DDi + 2 is the distance between the intersection point on side i + 2 and the end on side i + 2 diagonally opposite that chosen on side i.

ix) XX, YY: the x and y coordinates of the other end point of an admissible contour line. Thus X,Y (mentioned in i 2) and XX,YY are always joined.

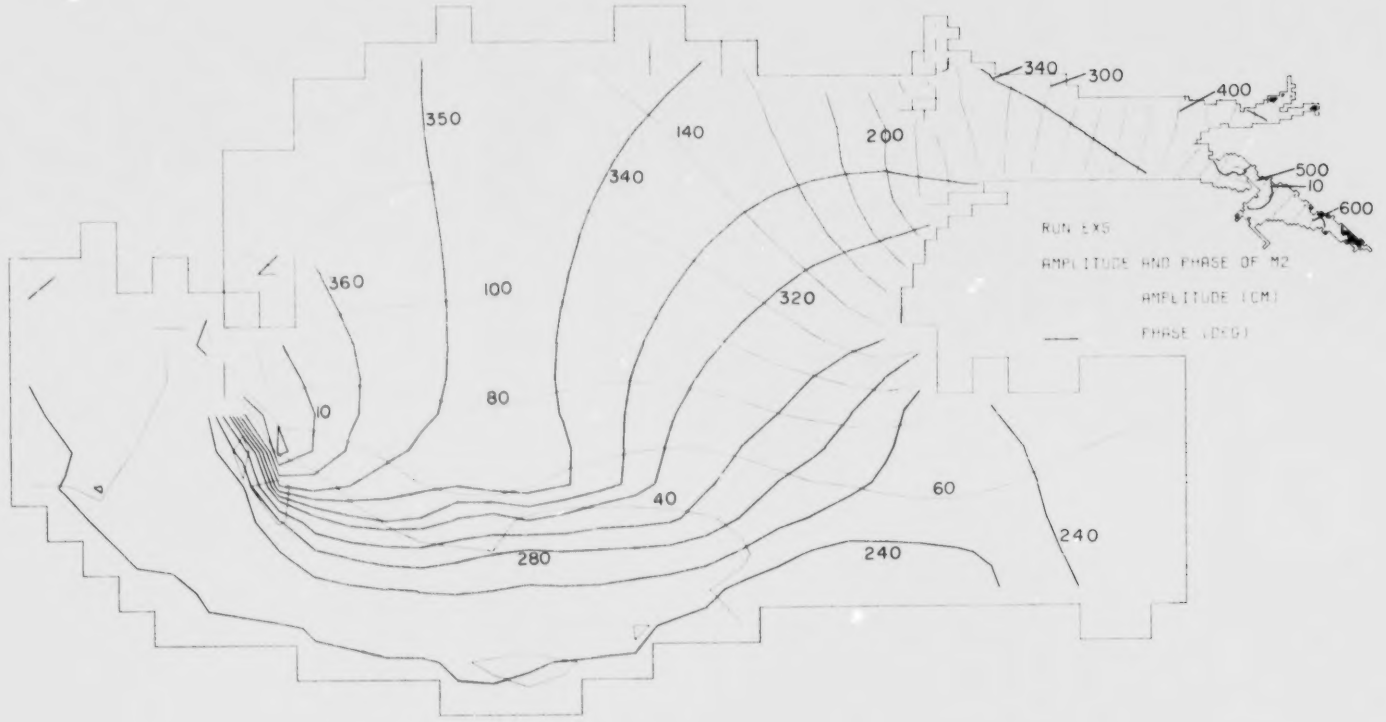

Figure 3

Sample plot of contours of the amplitude and phase of M2.

x) X1, Y1, X2, Y2: the x and y coordinates of the other intersection points calculated. These points are joined only if they are fully admissible. This contour line would then be the second one in a grid unit as was described in the description of subroutine TRACK.

f) In CELLIJ

i) IGRDNO: a dummy variable to read the grid number from TAPE2.

ii) IEND, JEND: dummy integers set equal to the x,y dimensions of the array of shore codes for each grid.

iii) FMT: a variable used to encode IEND into a format statement.

iv) CNTR: the current value to be contoured. CNTR takes on all values of CONTOUR and all contours are drawn in one grid unit before proceeding to the next grid unit.

g) In ROTATE

i) XX, YY, X, Y: the values of the x,y coordinates of the two end points of the contour line to be drawn. As control moves into subroutine ROTATE these are all measured relative to the local grid origin. This subroutine transforms these to coordinates with respect to the plot origin and returns control to TRACK so that the contour line may be drawn.

ii) X1, Y1, X2, Y2: dummy variables used in the transformation of XX, YY, X, Y from coordinates with respect to the grid origin to coordinates with respect to the plot origin.

1.4 VARIATIONS ON TIDAL AMPLITUDE AND PHASE

Introduction

The only variation to the program of 1.3 is that which contours the differences in amplitude and phase between the tide in the presence of a barrier and the natural regime. Contouring is identical to the program in 1.3 except for changes to the labelling of the plot.

The program to calculate these differences in amplitude and phase is stored on file BKDIFF. A listing is included of the source and the appropriate control cards.

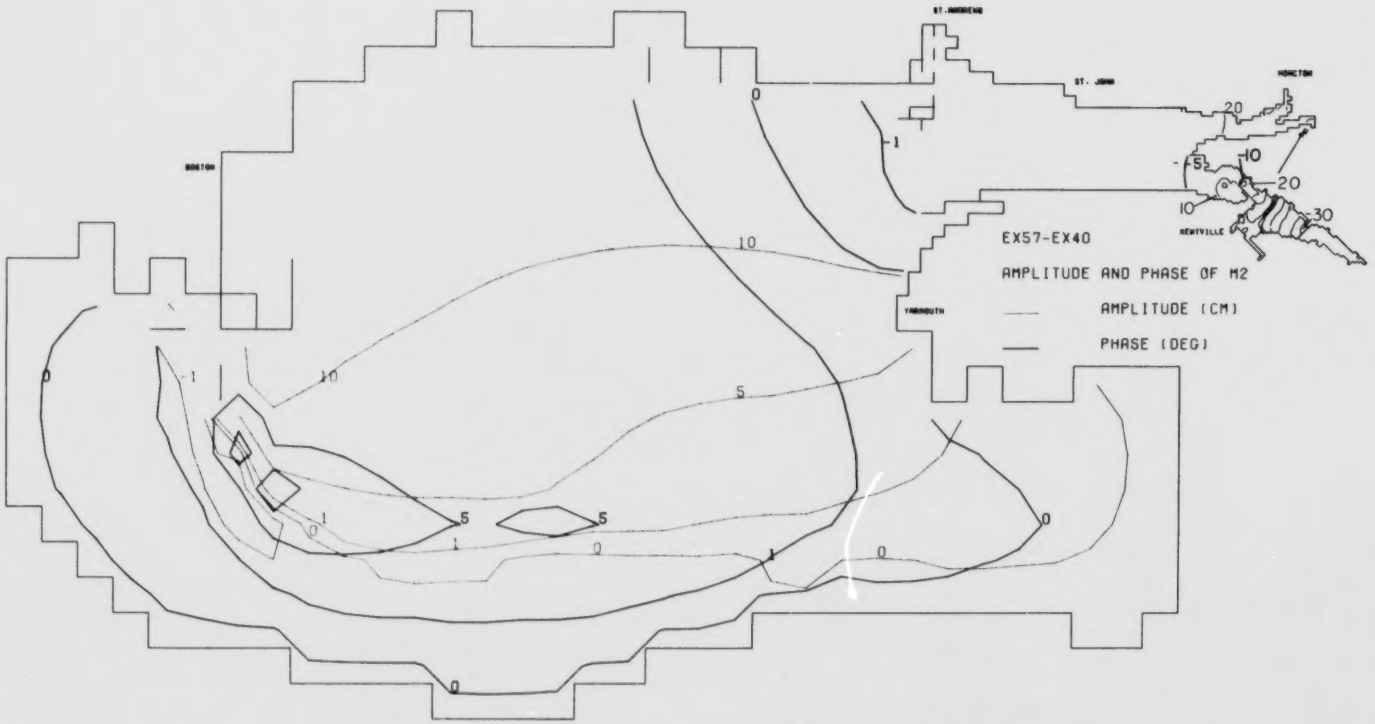

Figure 4

Sample plot of contours of the difference in amplitude and phase of M2 between a selected barrier and the natural regime.

Table 3

Modifications to Appendix E required to plot the amplitude and phase difference in M2 between a selected barrier and the natural regime.

```
      PROGRAM SUBTRCT(INPUT,OUTPUT,TAPE1,TAPE3,TAPE15)                  000001
C                                                                       000002
C          THIS PROGRAM READS DATA FROM 2 TAPES OF AMPLITUDE AND PHASE  000003
C           AND COMPUTES THE DIFFERENCE BETWEEN THE AMPLITUDES AND      000004
C           PHASES AT EACH GRID POINT.                                  000005
      DIMENSION A1(29,65),A2(15,28),A3(25,17),A4(25,24),A5(22,33)       000006
      DIMENSION B1(29,65),B2(15,28),B3(25,17),B4(25,24),B5(22,33)       000007
      DIMENSION C1(29,65),C2(15,28),C3(25,17),C4(25,24),C5(22,33)       000008
      REWIND 1                                                          000009
      REWIND 3                                                          000010
      REWIND 15                                                         000011
C                                                                       000012
C          FIRST THE DIFFERENCE IN AMPLITUDE IS CALCULATED AND THEN     000013
C           THE PHASE DIFFERENCE.                                       000014
      DO 900 II=1,2                                                     000015
C                                                                       000016
C          READ THE DATA FROM TAPES 1 AND 3.                            000017
      READ(3) A1,A2,A3,A4,A5                                            000018
      READ(1) B1,B2,B3,B4,B5                                            000019
C                                                                       000020
C          CALCULATE THE DIFFERENCES AT EACH GRID POINT IN EACH GRID.   000021
      DO 100 I=1,29                                                     000022
      DO 100 J=1,65                                                     000023
      C1(I,J)=A1(I,J)-B1(I,J)                                           000024
      IF(II.EQ.1) GO TO 100                                             000025
      IF(C1(I,J).GT.180.) C1(I,J)=C1(I,J)-360.                          000026
      IF(C1(I,J).LT.-180.) C1(I,J)=C1(I,J)+360.                         000027
100   CONTINUE                                                          000028
      DO 101 I=1,15                                                     000029
      DO 101 J=1,28                                                     000030
      C2(I,J)=A2(I,J)-B2(I,J)                                           000031
      IF(II.EQ.1) GO TO 101                                             000032
      IF(C2(I,J).GT.180.) C2(I,J)=C2(I,J)-360.                          000033
      IF(C2(I,J).LT.-180.) C2(I,J)=C2(I,J)+360.                         000034
101   CONTINUE                                                          000035
      DO 102 I=1,25                                                     000036
      DO 102 J=1,17                                                     000037
      C3(I,J)=A3(I,J)-B3(I,J)                                           000038
      IF(II.EQ.1) GO TO 102                                             000039
      IF(C3(I,J).GT.180.) C3(I,J)=C3(I,J)-360.                          000040
      IF(C3(I,J).LT.-180.) C3(I,J)=C3(I,J)+360.                         000041
102   CONTINUE                                                          000042
      DO 103 I=1,25                                                     000043
      DO 103 J=1,24                                                     000044
      C4(I,J)=A4(I,J)-B4(I,J)                                           000045
      IF(II.EQ.1) GO TO 103                                             000046
      IF(C4(I,J).GT.180.) C4(I,J)=C4(I,J)-360.                          000047
      IF(C4(I,J).LT.-180.) C4(I,J)=C4(I,J)+360.                         000048
103   CONTINUE                                                          000049
      DO 104 I=1,22                                                     000050
      DO 104 J=1,33                                                     000051
      C5(I,J)=A5(I,J)-B5(I,J)                                           000052
      IF(II.EQ.1) GO TO 104                                             000053
      IF(C5(I,J).GT.180.) C5(I,J)=C5(I,J)-360.                          000054
      IF(C5(I,J).LT.-180.) C5(I,J)=C5(I,J)+360.                         000055
104   CONTINUE                                                          000056
C                                                                       000057
C          OUTPUT THE RESULTS ONTO TAPE 15.                             000058
      WRITE(15) C1,C2,C3,C4,C5                                          000059
      IF(II.EQ.2) GO TO 510                                             000060
      PRINT 500                                                         000061
C                                                                       000062
C          PRINT OUT THE DIFFERENCES.                                   000063
500   FORMAT(5X,*AMPLITUDE CHANGE*)                                     000064
510   PRINT 501,((C1(I,J),I=1,25),J=1,65)                               000065
501   FORMAT(5X,25F5.0/)                                                000066
      PRINT 501,((C1(I,J),I=5,29),J=29,47)                              000067
      PRINT 511                                                         000068
511   FORMAT(1H1)                                                       000069
      PRINT 502,((C2(I,J),I=1,15),J=1,28)                               000070
502   FORMAT(5X,15F5.0/)                                                000071
      PRINT 511                                                         000072
      PRINT 501,((C3(I,J),I=1,25),J=1,17)                               000073
      PRINT 511                                                         000074
      PRINT 501,((C4(I,J),I=1,25),J=1,24)                               000075
      PRINT 511                                                         000076
      PRINT 503,((C5(I,J),I=1,22),J=1,33)                               000077
503   FORMAT(5X,22F5.0/)                                                000078
      IF(II.EQ.2) GO TO 900                                             000079
      PRINT 505                                                         000080
505   FORMAT(5X,*PHASE CHANGE*)                                         000081
900   CONTINUE                                                          000082
      STOP                                                              000083
      END                                                               000084
```

Table 3 (continued)

```
ILVBK,CM130000,T200,P2,MT2. BOB KEELEY                                          000001
ACCOUNT,*****.                                                                  000002
ATTACH,A,BKPEA,ID=MEDS.                                                         000003
ATTACH,TAPE11,DGFUNDY1E,ID=MEDS.                                                000004
LABEL,TAPE15,R,L=DGDXR11,T=999,X=SV.ER0143                                      000005
FTN,I=A,L=0.                                                                    000006
LGO.                                                                            000007
REWIND,TAPE3,TAPE15.                                                            000008
COPYBF,TAPE3,TAPE1.                                                             000009
UNLOAD,TAPE15.                                                                  000010
RETURN,TAPE15.                                                                  000011
LABEL,TAPE15,R,L=DGFEA6A8,T=999,X=SV.ER1781                                     000012
REWIND,TAPE3,TAPE11,TAPE5,TAPE6,LGO.                                            000013
LGO.                                                                            000014
RETURN,A,TAPE11,TAPE15,LGO.                                                     000015
ATTACH,A,BKDIFF,ID=MEDS.                                                        000016
FTN,I=A,L=0.                                                                    000017
LGO.                                                                            000018
REWIND,TAPE15.                                                                  000019
RETURN,TAPE1,TAPE3,A,LGO.                                                       000020
COPYBF,TAPE15,TAPE3.                                                            000021
ATTACH,A,BKBFAPHASEX,ID=MEDS.                                                   000022
ATTACH,TAPE1,BRBFGRIDX1,ID=MEDS.                                                000023
ATTACH,TAPE2,BKAPEDGE1,ID=MEDS.                                                 000024
ATTACH,LIB,MEDSPLIB,ID=MEDSPLIB,MR=1.                                           000025
LIBRARY,LIB.                                                                    000026
REQUEST,TAPE10,HY,S,SV,MT.MOUNT OCEANPLOT TAPE RETURN KEELEY STOP 1             000027
FTN,I=A,L=0.                                                                    000028
LGO.                                                                            000029
     1   48     1   30 1440                                                     000031
     1   48     1   30 1440                                                     000033
1.00543211.00                                                                   000035
   13                                                                           000036
 -40.00 -30.00 -20.00 -10.00  -5.00  -1.00                                      000037
   1.00   5.00  10.00  20.00  30.00  40.00                                      000038
   0.05                                                                         000039
   13                                                                           000040
 -40.00 -30.00 -20.00 -10.00  -5.00  -1.00                                      000041
   1.00   5.00  10.00  20.00  30.00  40.00                                      000042
   0.05                                                                         000043
EX50-EX40                                                                       000044
```

```
      CALL SYMBOL(HX1,HY2,.28,10HAMPLITUDE ,0.,10)                              000218
      CALL SYMBOL(HX2,HY2,.28,10HCHANGE(CM),0.,10)                              000219
      CALL SYMBOL(HX1,HY3,.28,10HPHASE CHAN,0.,10)                              000220
      CALL SYMBOL(HX2,HY3,.28,7HGE(DEG),0.,7)                                   000221
-                                                                               -
******* INSERT AFTER LINE 437 *******                                          I
      IF(Z(I,J).GT.180.) Z(I,J)=Z(I,J)-360.                                     I1
      IF(Z(I,J+1).GT.180.) Z(I,J+1)=Z(I,J+1)-360.                               I2
      IF(Z(I+1,J).GT.180.) Z(I+1,J)=Z(I+1,J)-360.                               I3
      IF(Z(I+1,J+1).GT.180.) Z(I+1,J+1)=Z(I+1,J+1)-360.                         I4
```

2.0 VECTOR PLOTS

All of the plots contained in this section have as their basis subroutines to plot any desired grid combinations and to plot arrows at each point or selected points in a grid. The first program plots tidal current vectors. A full source listing for it is included. Thereafter, variations to this basic program will be dealt with in a similar fashion as those in section 1.

Again sample results of these programs, or necessary tables, follow the documentation of each program. Some of the input files referenced in section 1 also are used by programs in this section. Appropriate references to the appendices are made in the documentation of these programs.

2.1 TIDAL CURRENTS

2.1.1 General Description

The program to plot tidal current vectors is stored on file BKBFUNDYUV1. The appropriate control cards are on file BKJBFUNDYUV. The program reads values for the elevation, and x and y components of the velocity at each grid point from a tape generated by Greenberg's model. These data have been calculated at 15 lunar minute intervals by the model. At present, the program plots only every fourth data set, i.e. the currents at lunar hourly intervals.

The present form of the program plots and labels either the combination of grids 54321 or 32100 in an area 10 by 14 inches. Three plots are made vertically and four horizontally to produce 12 hourly plots making up a full tidal cycle. Any other combination of grids requires an alteration of the scale factor of the plots and the position of the plot labels.

The coordinates defining the grid outlines are all measured with respect to the origin of the grid. But, the plots of all grids are made with respect to a single origin, the plot origin. Transformation from one origin to the other is accomplished by the variables XUP and YUP.

Grid1 causes some unusual problems because it is rotated by 45° from the horizontal. This means that a scale factor of $\sqrt{2}$ must be inserted and that coordinates with respect to the plot origin are linear combinations of the coordinates with respect to the local grid origin. Hence, whenever grid 1 is to be plotted, the above mentioned comments must be taken into consideration.

A library of the current vectors for the grid combinations 54321 and 32100 has been compiled for the no barrier case and the barriers B5, B6, A4, A6, B9, A8, B2, BG45 and BG56.

Attached to this documentation will be found a listing of the program which contains comment statements.

a) Program VECTOR

This is the main program and it directs the plotting procedures. Required arrays and variables are first read from input or tape. Data is next read from TAPE11 and if the set read corresponds to an integral lunar hour it is plotted. If not, the next data set is read.

Plotting begins with the grid which is the first element in array IWNTGRD. The appropriate subroutine GRIDi is called and the grid outline plotted. Next the averaged current vectors for that grid are plotted. When this is complete, either the next grid is plotted or, if all grids are done, the plot is labelled. The plot origin is then reset and the next data set is read. If all plots are complete, the program ends.

b) Subroutine GRID5, GRID4, GRID3, GRID2, GRID1

All these subroutines do the same thing for their respective grids. The first task is to move the position of the local origin of the last grid, or the plot origin as the case may be, to the position of the local origin for the next grid to be plotted. The scaling factor for the grid is also set at this time. Next the grid outline is plotted. Values for LATIO are set and the vectors in the grid are plotted. Control then returns to the main program.

c) Subroutine GRDPLOT

This is the subroutine that actually plots the grid outline. The appropriate coordinates and pen instructions are obtained from array IGRD. Scale factors and the local origin are supplied by the calling subroutine. After the outline is plotted, control returns to the calling subroutine, GRIDi.

d) Subroutine UVPLOT

This is the subroutine which calculates the tidal current vectors. The first task of the subroutine is to decide which vectors and how many are to be plotted in the grid under consideration. This is accomplished by the variables JQ and LATIO. As grids are plotted subsequent to the first one, the scale size frequently becomes smaller. So, if all vectors were plotted in all grids, the plot could become quite untidy. The variable LATIO alleviates this problem. LATIO scales like the variable SCALE but at no time is allowed to exceed the value of 4. Then, as subsequent grids are plotted, only every LATIO th. vector is plotted. In cases where the number of cells in a row, divided by LATIO is less than 2 a further treatment ensures the vector is centrally located in the row. The variable, JQ, simply keeps track of the rows for which the vectors are to be plotted.

Once it has been determined if the vectors are to be plotted, the average current values must be calculated. This is because for cell i,j, $U_{i,j}$ corresponds to the current crossing only the right hand side, and $V_{i,j}$ the current crossing the bottom of the cell. So, the two components of velocity in cell i,j are the average of $U_{i,j}$ and $U_{i-1,j}$ and the average of $V_{i,j}$ and $V_{i,j-1}$. This average is calculated for each vector and then the magnitude and direction of the current vector is plotted. If both U, and V are zero no plot is made. If a vector exceeds 5 inches in length, something has gone wrong and an X is plotted instead of the vector in the appropriate cell.

After the first grid has been plotted, a scale vector is plotted and labelled at the local origin. Control then returns to the calling subroutine GRIDi.

e) Subroutine MORECS

This is the subroutine which actually plots the current vectors. The magnitude and direction is supplied by subroutine UVPLOT. The vector is plotted centred in the cell.

2.1.2 Inputs Required

a) TAPE1: This consists of two parts. The first part contains the five arrays specifying the coordinates of the grid outlines with respect to each grid's local origin. These values are stored in the array IGRD. The second part consists of the five arrays of coordinates, again with respect to their local origins, specifying the regions covered by water. The values are stored in array IBNDRY. For the no barrier case the data for TAPE1 are stored on file BRBFGRIDX. For the barrier cases, this file is altered appropriately and stored as file BRBFGRIDX1. A listing of BRBFGRIDX is included in appendix B.

b) TAPE11: This is the data on the magnetic tape generated by Greenberg's model. It contains elevation and x and y components of velocity at each grid point in each grid, calculated at 15 lunar minute

intervals. There are 12 lunar hours of data or 48 data sets. Only every fourth set is plotted. The data on the tape is stored in format free form. The appropriate tape for TAPE11 varies for the different barrier cases.

c) TAPE10: All output for the calcomp plotter is written onto TAPE10 and saved on a magnetic tape.

d) INPUT: The values of FAC, IWNTGRD, AROSC and ALAB are read from input. The appropriate formats can be found in the program listing.

2.1.3 Output Generated

Values for FAC, IWNTGRD, AROSC and ALAB are echo printed as they are read. As plots are completed a message to this effect is printed.

2.1.4 Arrays

a) In COMMON

i) IGRD(I,J,K): is the array of coordinates defining the outlines of the grids.

K is the grid number

J is a sequential index of the coordinates needed to define the grid outline

I = 1 is a pen instruction

I = 2,3 the x,y coordinate of the point on the grid outline

ii) NPTS(K): is the array containing the number of coordinate pairs to draw a grid.

K is the grid number

NPTS(K) equals the maximum value of J for grid K in IGRD.

iii) IBNDRY(I,J,K): is the array specifying the regions of each grid for which vectors are to be plotted (i.e. the regions of each grid which are covered by water).

K is the grid number

J is a sequential index of the triplets, I, needed to specify a water covered region

I = 1,2 the minimum x and maximum x coordinates for the row given by I = 3.

iv) NPT(K): is the array containing the total number of triplets needed to define all regions covered by water. Thus, the maximum value of J for grid K in IBNDRY is equal to NPT(K).

v) YOU(I,J): a dummy array to contain the values of the U velocities for each grid as it is to be plotted. YOU takes on all values of U1 to U5 depending on the grid being plotted.

vi) VEE(I,J): a dummy array of the v velocity components and used like YOU.

vii) IWNTGRD(K): a five element array specifying which grids are to be plotted. Values for IWNTGRD must be sequential and in decreasing order. If all five grids are not to be plotted, IWNTGRD should be zero filled to five elements.

b) In VECTOR

i) Z1(I,J) to Z5(I,J): arrays holding the values of the elevation at coordinate I,J. These data are not used in this plotting program.

ii) U1(I,J) to U5(I,J): arrays holding the u component of velocity for grids 1 to 5 respectively.

iii) V1(I,J) to V5(I,J): arrays holding the v component of velocity for grids 1 to 5 respectively.

iv) BUFF(1): an array specifying the size of the buffer for the plotter.

c) In MORECS

i) PSIZE(I): an array specifying the length scale of the prototype symbol to be plotted. In this case, the prototype is 3.5 units long for the I th. symbol (the arrow).

ii) ISTART(I): an array specifying where in the prototype, the plotting is to start. To plot a complete symbol ISTART(I) = 1.

iii) IEND(I): an array similar to ISTART specifying the end point. For a complete symbol IEND(I) = number of coordinate pairs needed to define the whole symbol.

iv) X(I), Y(I): the coordinate pairs specifying the I th. symbol

v) IPEN(I): an array containing pen instructions corresponding to each coordinate pair. For IPEN = 3 the pen up condition is set and for IPEN = 2 the pen down condition is set.

2.1.5 Variables

a) In COMMON

i) XUP, YUP: these are the x,y coordinates of the local grid origin relative to the plot origin.

ii) AROSC: this is the scaling factor in units of 100 cm/sec. for the vectors in the plot. Refer to the description of BASESC for the use of AROSC.

b) In VECTOR

i) XORIG, YORIG: these are the x,y coordinates of the plot origin. They are altered after each plot is made so that 12 plots are spread out 3 vertically and 4 horizontally.

ii) BASESC: is the size in inches of the side of the largest grid cell to be plotted. At present it is set equal to 1. BASESC also establishes the size of the scale vector. Thus, for BASESC = 1 inch and AROSC = 4.5, a vector 1 inch long corresponds to a current of 450 cm/sec.

iii) FAC: this specifies the scaling factor for the whole plot. Thus, FAC*BASESC is the size of the largest grid unit to be plotted. FAC is varied for the different combinations of grids to be plotted so that they will fit in an area 10 by 14 inches. For the combination 54321 FAC = .35 and for 32100, FAC = .50.

iv) IGRDNO: a dummy variable to read the grid number from TAPE1.

v) ALAB: the label which is to be written on the plot to identify it. ALAB must be 10 characters or less.

vi) ALUNHR: this is the lunar hour corresponding to the data being plotted. As only every fourth data set is plotted, ALUNHR is incremented by 1 hour each fourth data set. The value of ALUNHR appears in the plot labelling.

vii) HX, HY: these are the x,y coordinates for the position of the title of the plot. These will vary from one grid combination to another. For combinations other then 54321 or 32100 changes to HX, HY must be made.

c) In GRID5, GRID4, GRID3, GRID2, GRID1

i) SCALE: this is the factor by which a grid unit is reduced from the size of a grid unit of the first grid plotted. In all cases SCALE = BASESC for the first grid plotted.

ii) LATIO: this is the factor by which the number of vectors plotted in a grid is reduced from the number plotted in the first grid. In no case is LATIO allowed to exceed four.

d) In GRDPLOT

i) XX,YY: the x,y coordinates of the points on the grid outline to be plotted.

e) In UVPLOT

i) RAD: the factor to convert radians to degrees.

ii) JQ: the starting row of the grid for which the regions covered by water are specified.

iii) I1, I2: the minimum and maximum x coordinates of the region covered by water in a row.

iv) JAY: the row of the grid for which I1, I2 apply.

v) IYE: a dummy variable for a do loop.

vi) XC, YC: the x,y coordinates of the center of the cell for which the vector is to be plotted.

vii) U,V: the averaged u,v components of the current.

viii) SIZE: the magnitude of the current scaled by AROSC.

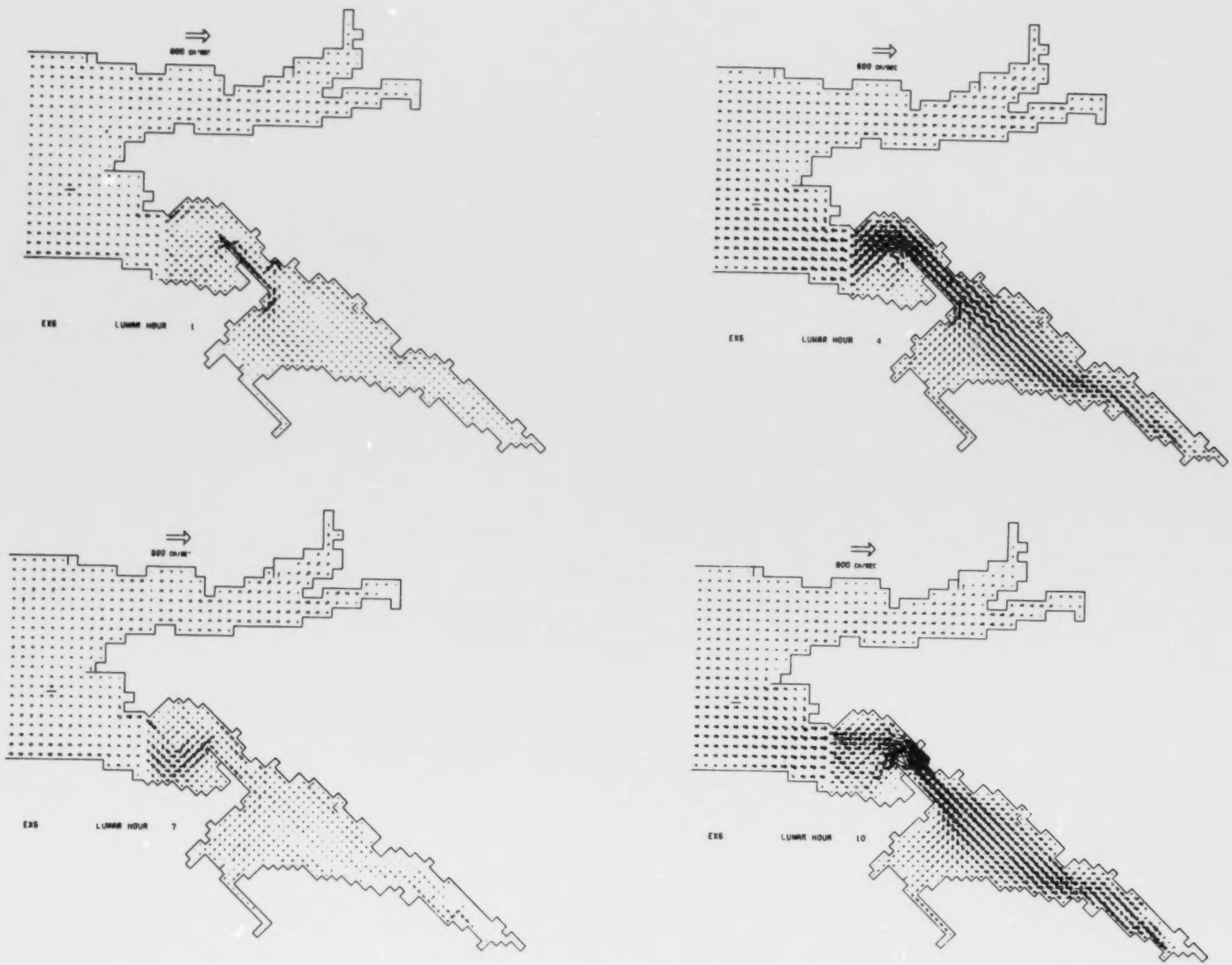

Figure 5

Sample plot of hourly current vectors.

Table 4

The source listing of the current vector plotting routine.

```
      PROGRAM VECTOR(INPUT,OUTPUT,TAPE1,TAPE10,TAPE11)                          000001
C                                                                               000002
C      THIS PROGRAM PLOTS CURRENT VECTORS FOR ANY SEQUENTIAL                    000003
C       COMBINATION OF GRIDS FROM D. GREENBURG'S BAY OF                         000004
C       FUNDY MODEL. (SEE REF. TO IWNTGRD)                                      000005
C                                                                               000006
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)               000007
      DIMENSION U1(29,65),U2(15,28),U3(25,17),U4(25,24),U5(22,33)               000008
      DIMENSION V1(29,65),V2(15,28),V3(25,17),V4(25,24),V5(22,33)               000009
      DIMENSION BUFF(1)                                                         000010
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC                     000011
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                        000012
      REWIND 1                                                                  000013
      REWIND 10                                                                 000014
      REWIND 11                                                                 000015
      XORIG=3.                                                                  000016
      YORIG=3.                                                                  000017
      BASESC=1.0                                                                000018
C                                                                               000019
C        READ BAY OF FUNDY GRID COORDINATES FROM TAPE 1                         000020
      DO 100 I=1,5                                                              000021
      KJ=6-I                                                                    000022
      READ(1,500) IGRDNO,NPTS(KJ)                                               000023
500   FORMAT(5X,I2,I3)                                                          000024
501   FORMAT(9(I1,I2,1X,I2))                                                    000025
      J=NPTS(KJ)                                                                000026
100   READ(1,501) ((IGRD(II,JJ,KJ),II=1,3),JJ=1,J)                              000027
      DO 102 I=1,5                                                              000028
503   FORMAT(7(I2,1X,I2,1X,I2))                                                 000029
C                                                                               000030
C       READ THE ARRAYS SPECIFYING THE REGIONS COVERED BY WATER                 000031
C         IN EACH GRID.                                                         000032
      READ(1,500) IGRDNO,NPT(I)                                                 000033
      J=NPT(I)                                                                  000034
102   READ(1,503) ((IBNDRY(II,JJ,I),II=1,3),JJ=1,J)                             000035
C                                                                               000036
C        READ FAC, IWNTGRD,PLOT TITLE FROM INPUT                                000037
      PRINT 876                                                                 000038
876   FORMAT(* *,*INPUT,FAC,IWNTGRD,AROSC*)                                     000039
      READ 502,FAC,(IWNTGRD(I),I=1,5),AROSC                                     000040
502   FORMAT(F4.2,5I1,F3.1)                                                     000041
      PRINT 400,FAC,(IWNTGRD(KN),KN=1,5),AROSC                                  000042
400   FORMAT(* *,*FAC=*,F5.2,* IWNTGRD=*,5I2,* AROSC=*,F4.1)                    000043
      READ 401,ALAB                                                             000044
401   FORMAT(A10)                                                               000045
      PRINT 809,ALAB                                                            000046
809   FORMAT(* *,*PLOT LABEL *,A10)                                             000047
C                                                                               000048
C          INITIALIZE PLOT ROUTINE AND SET ORIGIN TO THE BOTTOM LEFT            000049
C           HAND CORNER. PLOT IS WRITTEN ON TAPE 10.                            000050
      CALL PLOTS(BUFF,200,10)                                                   000051
      CALL PLOT(0.,-30.,-3)                                                     000052
C                                                                               000053
C          RESET ORIGIN TO 1 INCH IN AND UP FROM THE BOTTOM LEFT HAND           000054
C           CORNER. INITIALIZE XUP,YUP,SCALE.                                   000055
C       READ DATA FROM TAPE 11 BUT PLOT EVERY 4 TH SET                          000056
      CALL FACTOR(FAC)                                                          000057
      ALUNHR=1.                                                                 000058
      DO 779 NDATA=1,48                                                         000059
      READ(11) Z1,Z2,Z3,Z4,Z5                                                   000060
      READ(11) U1,U2,U3,U4,U5                                                   000061
      READ(11) V1,V2,V3,V4,V5                                                   000062
      IF(MOD(NDATA,4).NE.0) GO TO 779                                           000063
      CALL PLOT(XORIG,YORIG,-3)                                                 000064
      XUP=0.                                                                    000065
      YUP=0.                                                                    000066
C                                                                               000067
C          CHECK WHICH GRIDS ARE TO BE PLOTTED AND PROCEED ACCORDINGLY          000068
      DO 101 I=1,5                                                              000069
      IF(IWNTGRD(I).EQ.0) GO TO 10                                              000070
      GO TO (1,2,3,4,5) IWNTGRD(I)                                              000071
C                                                                               000072
C          GRID 5 (GULF OF MAINE)                                               000073
5     DO 50 IK=1,22                                                             000074
      DO 50 JK=1,33                                                             000075
      YOU(IK,JK)=U5(IK,JK)                                                      000076
50    VEE(IK,JK)=V5(IK,JK)                                                      000077
      CALL GRID5(I,BASESC)                                                      000078
      GO TO 101                                                                 000079
C                                                                               000080
C       GRID 4 (BAY OF FUNDY)                                                   000081
4     DO 40 IK=1,25                                                             000082
      DO 40 JK=1,24                                                             000083
      YOU(IK,JK)=U4(IK,JK)                                                      000084
40    VEE(IK,JK)=V4(IK,JK)                                                      000085
      CALL GRID4(I,BASESC)                                                      000086
      GO TO 101                                                                 000087
C                                                                               000088
C          GRID 3 (CHIGNECTO HEAD)                                              000089
3     DO 30 IK=1,25                                                             000090
      DO 30 JK=1,17                                                             000091
      YOU(IK,JK)=U3(IK,JK)                                                      000092
30    VEE(IK,JK)=V3(IK,JK)                                                      000093
      CALL GRID3(I,BASESC)                                                      000094
      GO TO 101                                                                 000095
C                                                                               000096
C          GRID 2 (CHIGNECTO BAY)                                               000097
2     DO 20 IK=1,15                                                             000098
      DO 20 JK=1,28                                                             000099
      YOU(IK,JK)=U2(IK,JK)                                                      000100
20    VEE(IK,JK)=V2(IK,JK)                                                      000101
      CALL GRID2(I,BASESC)                                                      000102
      GO TO 101                                                                 000103
C                                                                               000104
C          GRID 1 (MINAS BASIN)                                                 000105
1     DO 12 IK=1,29                                                             000106
      DO 12 JK=1,65                                                             000107
      YOU(IK,JK)=U1(IK,JK)                                                      000108
```

Table 4 (continued)

```
12    VEE(IK,JK)=V1(IK,JK)                                                    000109
      CALL GRID1(I,BASESC)                                                    000110
101   CONTINUE                                                                000111
C                                                                             000112
C         LABEL THE PLOT AND SET THE COORDINATES OF THE                       000113
C          ORIGIN IN PREPARATION FOR THE NEXT PLOT                            000114
10    IF(IWNTGRD(1).NE.3) GO TO 776                                           000115
      HX=7./FAC                                                               000116
      HY=3./FAC                                                               000117
      GO TO 775                                                               000118
776   HX=3.5/FAC                                                              000119
      HY=7.6/FAC                                                              000120
775   HHX=HX+2.1*FAC+1./FAC                                                   000121
      HHXX=HX-1.5/FAC                                                         000122
      CALL SYMBOL(HHXX,HY,.21,ALAB,0.,10)                                     000123
      CALL SYMBOL(HX,HY,.21,10HLUNAR HOUR,0.,10)                              000124
      CALL NUMBER(HHX,HY,.21,ALUNHR,0.,-1)                                    000125
      LUNHR=IFIX(ALUNHR)                                                      000126
      ALUNHR=ALUNHR+1.                                                        000127
      PRINT 802,LUNHR                                                         000128
802   FORMAT(* *,*PLOT*,I4,* COMPLETED*)                                      000129
      IF(MOD(LUNHR,3).EQ.0) GO TO 777                                         000130
      YORIG=11./FAC                                                           000131
      XORIG=0.                                                                000132
      GO TO 779                                                               000133
777   XORIG=14./FAC                                                           000134
      YORIG=-22./FAC                                                          000135
779   CONTINUE                                                                000136
      CALL PLOT(0.,0.,999)                                                    000137
      STOP                                                                    000138
      END                                                                     000139
C                                                                             000140
      SUBROUTINE GRID5(I,BASESC)                                              000141
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC                   000142
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                      000143
C                                                                             000144
C        MOVE PEN TO THE ORIGIN OF GRID 5                                     000145
      XUP=27.                                                                 000146
      YUP=22.                                                                 000147
      CALL PLOT(XUP,YUP,3)                                                    000148
      SCALE=BASESC                                                            000149
      CALL GRDPLOT(SCALE,I)                                                   000150
      LATIO=IFIX(BASESC/SCALE)                                                000151
      CALL UVPLOT(I,SCALE,LATIO)                                              000152
C                                                                             000153
      RETURN                                                                  000154
      END                                                                     000155
C                                                                             000156
      SUBROUTINE GRID4(I,BASESC)                                              000157
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC                   000158
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                      000159
C                                                                             000160
C        CHECK IF GRID 4 IS THE FIRST TO BE PLOTTED                           000161
      IF(I.EQ.1) GO TO 41                                                     000162
      SCALE=BASESC/3.                                                         000163
      XUP=XUP-9.*BASESC+24.*SCALE                                             000164
      YUP=YUP-4.*BASESC+7.*SCALE                                              000165
      GO TO 42                                                                000166
C                                                                             000167
C        SET PEN TO ORIGIN OF GRID 4                                          000168
41    XUP=24.                                                                 000169
      YUP=25.                                                                 000170
      SCALE=BASESC                                                            000171
      CALL PLOT(XUP,YUP,3)                                                    000172
42    CALL GRDPLOT(SCALE,I)                                                   000173
      LATIO=1                                                                 000174
      CALL UVPLOT(I,SCALE,LATIO)                                              000175
C                                                                             000176
      RETURN                                                                  000177
      END                                                                     000178
C                                                                             000179
      SUBROUTINE GRID3(I,BASESC)                                              000180
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC                   000181
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                      000182
C                                                                             000183
C        CHECK IF GRID 3 IS THE FIRST TO BE PLOTTED                           000184
      IF(I.EQ.1) GO TO 31                                                     000185
      SCALE=BASESC/9.                                                         000186
      IF(IWNTGRD(1).EQ.4) SCALE=SCALE*3.                                      000187
C                                                                             000188
CC       SET PEN TO ORIGIN OF GRID 3                                          000189
      XUP=XUP-2.*SCALE*3.+17.*SCALE                                           000190
      YUP=YUP-9.*SCALE*3.+2.*SCALE                                            000191
      GO TO 34                                                                000192
C                                                                             000193
C        IF GRID 3 IS THE FIRST WE MUST CHECK HOW MANY GRIDS ARE TO           000194
C         FOLLOW IN ORDER TO SCALE THE PLOTS CORRECTLY TO FIT ON ONE          000195
C         PLOT                                                                000196
C                                                                             000197
31    IF(IWNTGRD(I+1).EQ.2.AND.IWNTGRD(I+2).EQ.1) GO TO 33                    000198
      IF(IWNTGRD(I+1).EQ.1) GO TO 33                                          000199
C                                                                             000200
C        ADJUST SCALE SO THE WHOLE PLOT FITS                                  000201
      SCALE=BASESC*.8                                                         000202
      GO TO 35                                                                000203
33    SCALE=BASESC*.4                                                         000204
35    XUP=17.                                                                 000205
      YUP=18.                                                                 000206
      CALL PLOT(XUP,YUP,3)                                                    000207
34    CALL GRDPLOT(SCALE,I)                                                   000208
      LATIO=IFIX(BASESC/SCALE)                                                000209
      CALL UVPLOT(I,SCALE,LATIO)                                              000210
C                                                                             000211
      RETURN                                                                  000212
      END                                                                     000213
C                                                                             000214
      SUBROUTINE GRID2(I,BASESC)                                              000215
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC                   000216
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)
```

Table 4 (continued)

```
C                                                                       000217
C        CHECK IF GRID 2 IS THE FIRST TO BE PLOTTED                     000218
      IF(I.EQ.1) GO TO 21                                               000219
C                                                                       000220
C        SET THE SCALES CORRECTLY ON THE PLOTS                          000221
      GO TO (22,23,24) (IWNTGRD(1)-2)                                   000222
24    SCALE=BASESC/9.                                                   000223
      GO TO 26                                                          000224
23    SCALE=BASESC/3.                                                   000225
      GO TO 26                                                          000226
C                                                                       000227
C        CHECK IF GRID 1 IS TO BE PLOTTED                               000228
22    IF(IWNTGRD(I+1).EQ.1) GO TO 25                                    000229
      SCALE=BASESC*.8                                                   000230
      GO TO 26                                                          000231
25    SCALE=BASESC*.4                                                   000232
26    XUP=XUP+(-2.+27.)*SCALE                                           000233
      YUP=YUP+(-3.+8.)*SCALE                                            000234
      GO TO 27                                                          000235
21    XUP=27.                                                           000236
      YUP=15.                                                           000237
      SCALE=BASESC                                                      000238
      CALL PLOT(XUP,YUP,3)                                              000239
27    CALL GRDPLOT(SCALE,I)                                             000240
      LATIO=IFIX(BASESC/SCALE)                                          000241
      CALL UVPLOT(I,SCALE,LATIO)                                        000242
C                                                                       000243
      RETURN                                                            000244
      END                                                               000245
C                                                                       000246
      SUBROUTINE GRID1(I,BASESC)                                        000247
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC             000248
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                000249
      ROOT2=SQRT(2.)                                                    000250
C                                                                       000251
C        CHECK IF GRID 1 IS THE ONLY ONE TO BE PLOTTED                  000252
      IF(I.EQ.1) GO TO 11                                               000253
C                                                                       000254
C          SET SCALES FOR THE PLOT                                      000255
      GO TO (12,12,13,14) (IWNTGRD(1)-1)                                000256
14    SCALE=(BASESC/9.)/ROOT2                                           000257
      GO TO 15                                                          000258
13    SCALE=(BASESC/3.)/ROOT2                                           000259
      GO TO 15                                                          000260
12    SCALE=(BASESC/ROOT2)*.4                                           000261
15    IF(IWNTGRD(I-1).EQ.2) GO TO 16                                    000262
      XUP=XUP-3.*SCALE*ROOT2+(18.+65.)*SCALE/ROOT2                      000263
      YUP=YUP-18.*SCALE*ROOT2+(18.-65.)*SCALE/ROOT2                     000264
      GO TO 17                                                          000265
16    XUP=XUP-28.*SCALE*ROOT2+(18.+65.)*SCALE/ROOT2                     000266
      YUP=YUP-23.*SCALE*ROOT2+(18.-65.)*SCALE/ROOT2                     000267
      GO TO 17                                                          000268
11    SCALE=BASESC/ROOT2                                                000269
      YUP=29.*SCALE                                                     000270
      XUP=65.*SCALE                                                     000271
      CALL PLOT(XUP,YUP,3)                                              000272
17    CALL GRDPLOT(SCALE,I)                                             000273
      LATIO=IFIX(BASESC/SCALE)                                          000274
      CALL UVPLOT(I,SCALE,LATIO)                                        000275
C                                                                       000276
      RETURN                                                            000277
      END                                                               000278
C                                                                       000279
      SUBROUTINE GRDPLOT(SCALE,K)                                       000280
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC             000281
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                000282
C                                                                       000283
C        SUBROUTINE TO PLOT THE DESIRED GRID                            000284
C        PEN INSTRUCTIONS ARE INCLUDED IN IGRD                          000285
      J=NPTS(IWNTGRD(K))                                                000286
      ROOT2=SQRT(2.)                                                    000287
      DO 120 I=1,J                                                      000288
      IP=2                                                              000289
      IF(IWNTGRD(K).NE.1) GO TO 20                                      000290
      XX=-FLOAT(IGRD(3,I,IWNTGRD(K)))*SCALE                             000291
      YY=-FLOAT(IGRD(2,I,IWNTGRD(K)))*SCALE                             000292
      FX=XX/ROOT2+YY/ROOT2                                              000293
      FY=YY/ROOT2-XX/ROOT2                                              000294
      XX=XUP+FX                                                         000295
      YY=YUP+FY                                                         000296
      GO TO 21                                                          000297
20    XX=XUP-FLOAT(IGRD(3,I,IWNTGRD(K)))*SCALE                          000298
      YY=YUP-FLOAT(IGRD(2,I,IWNTGRD(K)))*SCALE                          000299
21    IPEN=IGRD(1,I,IWNTGRD(K))                                         000300
      IF(IPEN.EQ.2) IP=3                                                000301
120   CALL PLOT(XX,YY,IP)                                               000302
      RETURN                                                            000303
      END                                                               000304
C                                                                       000305
      SUBROUTINE UVPLOT(I,SCALE,LATIO)                                  000306
C                                                                       000307
C        SUBROUTINE TO CALCULATE THE MAGNITUDE AND DIRECTION            000308
C        OF THE CURRENT VECTOR TO BE PLOTTED.                           000309
C                                                                       000310
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC             000311
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                000312
      RAD=180./3.14159                                                  000313
      IF(IWNTGRD(1).EQ.3) LATIO=1                                       000314
      ROOT2=SQRT(2.)                                                    000315
      JQ=IBNDRY(3,1,IWNTGRD(I))                                         000316
      JI1=NPT(IWNTGRD(I))                                               000317
      DO 102 J=1,JI1                                                    000318
C                                                                       000319
C        DETERMINE THE REGION COVERED BY WATER IN ROW JAY               000320
      I1=IBNDRY(1,J,IWNTGRD(I))                                         000321
      I2=IBNDRY(2,J,IWNTGRD(I))                                         000322
      JAY=IBNDRY(3,J,IWNTGRD(I))                                        000323
      IF(LATIO.EQ.1) GO TO 88                                           000324
```

Table 4 (continued)

```
      IF(LATIO.GT.4) LATIO=4                                                    000325
      IF((I2-I1).LE.(LATIO*2)) I1=I1+(I2-I1)/2                                  000326
      IF(JAY.LT.JQ) GO TO 102                                                   000327
      IF(JAY.EQ.JQ) GO TO 88                                                    000328
      JQ=JQ+LATIO                                                               000329
      GO TO 102                                                                 000330
88    CONTINUE                                                                  000331
      DO 100 IYE=I1,I2,LATIO                                                    000332
C                                                                               000333
C       PLOT EVERY LATIO TH. VECTOR IN ROW JAY                                  000334
      XC=XUP-(FLOAT(JAY)+.5)*SCALE                                              000335
      YC=YUP-(FLOAT(IYE)+.5)*SCALE                                              000336
      IF(IWNTGRD(I).NE.1) GO TO 89                                              000337
      XC1=-(FLOAT(JAY)+.5)*SCALE                                                000338
      YC1=-(FLOAT(IYE)+.5)*SCALE                                                000339
      XC=XUP+XC1/ROOT2+YC1/ROOT2                                                000340
      YC=YUP+YC1/ROOT2-XC1/ROOT2                                                000341
89    IF(IYE.EQ.I1.AND.J.EQ.1) GO TO 48                                         000342
      IF(J.EQ.1) GO TO 49                                                       000343
      IF(IYE.EQ.I1) GO TO 50                                                    000344
      U=(YOU(IYE,JAY)+YOU(IYE-1,JAY))*.5                                        000345
      V=(VEE(IYE,JAY)+VEE(IYE,JAY-1))*.5                                        000346
      GO TO 51                                                                  000347
50    U=.5*YOU(IYE,JAY)                                                         000348
      V=(VEE(IYE,JAY)+VEE(IYE,JAY-1))*.5                                        000349
      GO TO 51                                                                  000350
49    U=(YOU(IYE,JAY)+YOU(IYE-1,JAY))*.5                                        000351
      V=.5*VEE(IYE,JAY)                                                         000352
      GO TO 51                                                                  000353
48    U=.5*YOU(IYE,JAY)                                                         000354
      V=.5*VEE(IYE,JAY)                                                         000355
C                                                                               000356
C       SCALE THE VECTOR ACCORDING TO AROSC                                     000357
51    SIZE=SQRT(U**2+V**2)/(AROSC*100.)                                         000358
      IF(SIZE.GT.5.) GO TO 14                                                   000359
      IF(U.EQ.0..AND.V.EQ.0.) GO TO 100                                         000360
      ANG=ATAN2(-U,V)*RAD                                                       000361
      IF(IWNTGRD(I).NE.1) GO TO 52                                              000362
      ANG=ANG-45.                                                               000363
C                                                                               000364
C       PLOT THE VECTOR                                                         000365
52    CALL NORECS(XC,YC,SIZE,1,ANG,1)                                           000366
      GO TO 100                                                                 000367
14    CALL SYMBOL(XC,YC,.07,1HX,0.,1)                                           000368
100   CONTINUE                                                                  000369
102   CONTINUE                                                                  000370
C                                                                               000371
C       DRAW A SAMPLE SCALE VECTOR AT THE ORIGIN FOR ONLY                       000372
C         THE FIRST PLOT.                                                       000373
      IF(I.NE.1) GO TO 101                                                      000374
      CALL NORECS(XUP,YUP,1.,1,0.,1)                                            000375
      XH=XUP-1.                                                                 000376
      YH=YUP-.75                                                                000377
      XR=XUP-.25                                                                000378
      Q=AROSC*100.                                                              000379
      CALL NUMBER(XH,YH,.2,Q,0.,-1)                                             000380
      CALL SYMBOL(XR,YH,.15,6HCM/SEC,0.,6)                                      000381
101   CONTINUE                                                                  000382
      RETURN                                                                    000383
      END                                                                       000384
C                                                                               000385
      SUBROUTINE NORECS(XC,YC,SIZE,ID,ANG,ICODE)                                000386
C                                                                               000387
C       THIS SUBROUTINE PLOTS CENTRED SYMBOLS. NEW SYMBOLS ARE                  000388
C         EASILY ADDED.                                                         000389
C       SIZE= THE LENGTH OF SOME CHOSEN DIMENSION OF THE SYMBOL.                000390
C       ID= IDENTIFICATION OF THE SYMBOL = 1,2,3....                            000391
C       ICODE IS NOT USED                                                       000392
      DIMENSION PSIZE(10),ISTART(10),IEND(10),X(30),Y(30),IPEN(30)              000393
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5),AROSC                     000394
      COMMON YOU(29,65),VEE(29,65),IBNDRY(3,76,5),NPT(5)                        000395
      DATA RPD/.017453293/,ANGSAV/0./,CTH/1./,STH/0./                           000396
C                                                                               000397
C       ID = 1 = ARROW                                                          000398
      DATA PSIZE/3.5/,ISTART/1/,IEND/8/                                         000399
      DATA (X(I),I=1,8)/-1.5,1.2,1.,2.,1.,1.2,-1.5,0./                          000400
      DATA (Y(I),I=1,8)/.3,.3,1.,0.,-1.,-.3,-.3,0./                             000401
      DATA (IPEN(I),I=1,8)/3,2,2,2,2,2,2,3/                                     000402
C                                                                               000403
C       INITIALIZE AND PLOT THE ARROW                                           000404
      IS=ISTART(ID)                                                             000405
      IE=IEND(ID)                                                               000406
      FAC=SIZE/PSIZE(ID)                                                        000407
      IF(ANG.EQ.ANGSAV) GO TO 100                                               000408
      CTH=COS(ANG*RPD)                                                          000409
      STH=SIN(ANG*RPD)                                                          000410
100   ANGSAV=ANG                                                               000411
      DO 200 I=IS,IE                                                            000412
      XT=(CTH*X(I)-STH*Y(I))*FAC+XC                                             000413
      YT=(STH*X(I)+CTH*Y(I))*FAC+YC                                             000414
200   CALL PLOT(XT,YT,IPEN(I))                                                  000415
      RETURN                                                                    000416
      END                                                                       000417
```

ix) ANG: the direction of the current.

x) XH,YH: the x,y positions at which the scale vector is to be plotted. This is always within 1 inch of the local origin of the first grid plotted.

f) In MORECS

i) RPD: conversion factor of degrees to radians.

ii) FAC: the ratio of the magnitude of the vector to be plotted to the prototype.

iii) CTH, STH: the value of the sine and cosine of the direction of the vector.

iv) XT, YT: the coordinates of the points defining the symbol to be plotted.

2.2 VARIATIONS ON TIDAL CURRENTS

The programs contained within this subsection are those which use the basic tidal vector plotting program. Minor variations to the program or calculations using elevations and i,j components of the currents prior to plotting constitute the variations. In all cases these preparatory programs and/or changes to the basic vector plotting program will be listed. Sample results of the programs will also be illustrated.

2.2.1 Residual Tidal Currents

The calculation of the residual tidal currents is accomplished by program RESID stored on disc as BKRESIDX. A source listing of this program follows. Comment cards within the program are adequate to explain the calculations which are performed.

The output from RESID is written on a scratch tape and is designed to be compatible with the format free data input used in the current vector plotting program discussed in 2.1. Again, only those changes that were required to produce the desired plot were made. Thus, extraneous statements and/or variables may be present in the program. The only changes to the program of 2.1 were to alter the label of the plot and to ensure only one plot is generated. These changes and the resulting plot are illustrated immediately following. The plotting program is stored on disc as BKBFUNDYUVRX.

2.2.2 Stokes Drift

The program to calculate the Stokes drift is on cards and is called program STOKES. A listing is included here. Comment statements are adequate to explain the program.

Because the values of u and v are not calculated at the same spot as Z, u's and v's are averaged before multiplication by the depth. Thus for the calculation of the Stokes drift $SD = \overline{u(Z + h)} - \overline{uh}$ the u is the average at the position of h,Z in the grid. NB $\overline{\ }$ means a time average.

Because averaging of u and v occurs in the calculation of the Stokes drift, averaging in the current vector plotting program (as is done for the other vector plots) is redundant. A listing of this program with the lines which have been inserted or changed follows:

Figure 6

Sample plot of current residual vectors.

Table 5

The source listing of the program to calculate current residuals and the modifications to Table 4 required in order to plot the residual currents.

```
      PROGRAM RESID(INPUT,OUTPUT,TAPE2,TAPE11)                          000001
C                                                                       000002
C          THIS PROGRAM READS U,V VELOCITIES GENERATED BY D. GREENBERG'S 000003
C           BAY OF FUNDY MODEL AND AVERAGES THEM OVER A TIDAL CYCLE.    000004
C           VALUES OF U AND V ARE TABULATED AT 15 LUNAR MINUTE INTERVALS 000005
      DIMENSION U1(29,65),U2(15,28),U3(25,17),U4(25,24),U5(22,33)       000006
      DIMENSION V1(29,65),V2(15,28),V3(25,17),V4(25,24),V5(22,33)       000007
      DIMENSION A1(29,65),A2(15,28),A3(25,17),A4(25,24),A5(22,33)       000008
      DIMENSION B1(29,65),B2(15,28),B3(25,17),B4(25,24),B5(22,33)       000009
      REWIND 11                                                         000010
      REWIND 2                                                          000011
C                                                                       000012
C          ZERO THE ARRAYS A(N) , B(N)                                  000013
      DO 100 I=1,29                                                     000014
      DO 100 J=1,65                                                     000015
      A1(I,J)=0.                                                        000016
100   B1(I,J)=0.                                                        000017
      DO 101 I=1,15                                                     000018
      DO 101 J=1,28                                                     000019
      A2(I,J)=0.                                                        000020
101   B2(I,J)=0.                                                        000021
      DO 102 I=1,25                                                     000022
      DO 102 J=1,17                                                     000023
      A3(I,J)=0.                                                        000024
102   B3(I,J)=0.                                                        000025
      DO 103 I=1,25                                                     000026
      DO 103 J=1,24                                                     000027
      A4(I,J)=0.                                                        000028
103   B4(I,J)=0.                                                        000029
      DO 104 I=1,22                                                     000030
      DO 104 J=1,33                                                     000031
      A5(I,J)=0.                                                        000032
104   B5(I,J)=0.                                                        000033
C                                                                       000034
C          READ THE U,V VALUES FOR EACH TIME STEP AND CALCULATE SUMS.   000035
      DO 105 II=1,48                                                    000036
      READ(2)                                                           000037
      READ(2) U1,U2,U3,U4,U5                                            000038
      READ(2) V1,V2,V3,V4,V5                                            000039
      DO 106 I=1,29                                                     000040
      DO 106 J=1,65                                                     000041
      A1(I,J)=A1(I,J)+U1(I,J)                                           000042
106   B1(I,J)=B1(I,J)+V1(I,J)                                           000043
      DO 107 I=1,15                                                     000044
      DO 107 J=1,28                                                     000045
      A2(I,J)=A2(I,J)+U2(I,J)                                           000046
107   B2(I,J)=B2(I,J)+V2(I,J)                                           000047
      DO 108 I=1,25                                                     000048
      DO 108 J=1,17                                                     000049
      A3(I,J)=A3(I,J)+U3(I,J)                                           000050
108   B3(I,J)=B3(I,J)+V3(I,J)                                           000051
      DO 109 I=1,25                                                     000052
      DO 109 J=1,24                                                     000053
      A4(I,J)=A4(I,J)+U4(I,J)                                           000054
109   B4(I,J)=B4(I,J)+V4(I,J)                                           000055
      DO 110 I=1,22                                                     000056
      DO 110 J=1,33                                                     000057
      A5(I,J)=A5(I,J)+U5(I,J)                                           000058
110   B5(I,J)=B5(I,J)+V5(I,J)                                           000059
105   CONTINUE                                                          000060
C                                                                       000061
C          AVERAGE OVER 12 LUNAR HOURS.                                 000062
      DO 111 I=1,29                                                     000063
      DO 111 J=1,65                                                     000064
      A1(I,J)=A1(I,J)/48.                                               000065
111   B1(I,J)=B1(I,J)/48.                                               000066
      DO 112 I=1,15                                                     000067
      DO 112 J=1,28                                                     000068
      A2(I,J)=A2(I,J)/48.                                               000069
112   B2(I,J)=B2(I,J)/48.                                               000070
      DO 113 I=1,25                                                     000071
      DO 113 J=1,17                                                     000072
      A3(I,J)=A3(I,J)/48.                                               000073
113   B3(I,J)=B3(I,J)/48.                                               000074
      DO 114 I=1,25                                                     000075
      DO 114 J=1,24                                                     000076
      A4(I,J)=A4(I,J)/48.                                               000077
114   B4(I,J)=B4(I,J)/48.                                               000078
      DO 115 I=1,22                                                     000079
      DO 115 J=1,33                                                     000080
      A5(I,J)=A5(I,J)/48.                                               000081
115   B5(I,J)=B5(I,J)/48.                                               000082
C                                                                       000083
C          WRITE OUT THE RESULTS. NOTE THAT THE FIRST WRITE IS          000084
C           A DUMMY USED ONLY TO INSURE THAT THE FORM OF THE OUTPUT     000085
C           TAPE IS THE SAME AS THE INPUT TAPE.                         000086
      WRITE(11) U1,U2,U3,U4,U5                                          000087
      WRITE(11) A1,A2,A3,A4,A5                                          000088
      WRITE(11) B1,B2,B3,B4,B5                                          000089
      STOP                                                              000090
      END                                                               000091
```

```
      DO 779 NDATA=4,4                                                  000059
-                                                                       -
******* DELETE LINES 124 AND 125 *******                                D
```

Figure 7

Sample plot of Stokes drift vectors.

Table 6

The source listing of the program to calculate the Stokes drift and the modifications to Table 4 required in order to plot the Stokes drift vectors.

```
      PROGRAM STOKES(INPUT,OUTPUT,TAPE1,TAPE2,TAPE11)                    000001
      DIMENSION H1(29,65),H2(15,28),H3(25,17),H4(25,24),H5(22,33)        000002
      DIMENSION SU1(29,65),SU2(15,28),SU3(25,17),SU4(25,24),SU5(22,33)   000003
      DIMENSIONSZU1(29,65),SZU2(15,28),SZU3(25,17),SZU4(25,24),SZU5(22,3 000004
     +3)                                                                 000005
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)        000006
      DIMENSION U1(29,65),U2(15,28),U3(25,17),U4(25,24),U5(22,33)        000007
501   FORMAT(4E15.4)                                                     000008
C                                                                        000009
C        READ THE DEPTH GRID                                             000010
      READ(1) H1,H2,H3,H4,H5                                             000011
      WRITE(11) H1,H2,H3,H4,H5                                           000012
      DO 210 IV=1,2                                                      000013
      REWIND 2                                                           000014
C                                                                        000015
C        ZERO ALL ARRAYS                                                 000016
      DO 101 I=1,29                                                      000017
      DO 101 J=1,65                                                      000018
      SU1(I,J)=0.                                                        000019
101   SZU1(I,J)=0.                                                       000020
      DO 102 I=1,15                                                      000021
      DO 102 J=1,28                                                      000022
      SU2(I,J)=0.                                                        000023
102   SZU2(I,J)=0.                                                       000024
      DO 103 I=1,25                                                      000025
      DO 103 J=1,17                                                      000026
      SU3(I,J)=0.                                                        000027
103   SZU3(I,J)=0.                                                       000028
      DO 104 I=1,25                                                      000029
      DO 104 J=1,24                                                      000030
      SU4(I,J)=0.                                                        000031
104   SZU4(I,J)=0.                                                       000032
      DO 105 I=1,22                                                      000033
      DO 105 J=1,33                                                      000034
      SU5(I,J)=0.                                                        000035
105   SZU5(I,J)=0.                                                       000036
      DO 200 IC=1,48                                                     000037
C                                                                        000038
C        READ THE ELEVATION                                              000039
      READ(2) Z1,Z2,Z3,Z4,Z5                                             000040
C                                                                        000041
C        READ EITHER THE U OR V COMPONENT                                000042
      IF(IV.EQ.2) GO TO 300                                              000043
      READ(2) U1,U2,U3,U4,U5                                             000044
      READ(2)                                                            000045
      GO TO 301                                                          000046
300   READ(2)                                                            000047
      READ(2) U1,U2,U3,U4,U5                                             000048
301   CONTINUE                                                           000049
C                                                                        000050
C        USE THE AVERAGE VECTORS AND SUM OVER A TIDAL CYCLE              000051
      DO 111 I=1,29                                                      000052
      DO 111 J=1,65                                                      000053
      IF(IV.EQ.2) GO TO 141                                              000054
      U=(U1(I,J)+U1(I-1,J))*.5                                           000055
      GO TO 151                                                          000056
141   U=(U1(I,J)+U1(I,J-1))*.5                                           000057
151   IF(U.GT.1000.) U=0.                                                000058
      SU1(I,J)=SU1(I,J)+U                                                000059
111   SZU1(I,J)=SZU1(I,J)+(H1(I,J)+Z1(I,J))*U                            000060
      DO 112 I=1,15                                                      000061
      DO 112 J=1,28                                                      000062
      IF(IV.EQ.2) GO TO 142                                              000063
      U=(U2(I,J)+U2(I-1,J))*.5                                           000064
      GO TO 152                                                          000065
142   U=(U2(I,J)+U2(I,J-1))*.5                                           000066
152   IF(U.GT.1000.) U=0.                                                000067
      SU2(I,J)=SU2(I,J)+U                                                000068
112   SZU2(I,J)=SZU2(I,J)+(H2(I,J)+Z2(I,J))*U                            000069
      DO 113 I=1,25                                                      000070
      DO 113 J=1,17                                                      000071
      IF(IV.EQ.2) GO TO 143                                              000072
      U=(U3(I,J)+U3(I-1,J))*.5                                           000073
      GO TO 153                                                          000074
143   U=(U3(I,J)+U3(I,J-1))*.5                                           000075
153   IF(U.GT.1000.) U=0.                                                000076
      SU3(I,J)=SU3(I,J)+U                                                000077
113   SZU3(I,J)=SZU3(I,J)+(H3(I,J)+Z3(I,J))*U                            000078
      DO 114 I=1,25                                                      000079
      DO 114 J=1,24                                                      000080
      IF(IV.EQ.2) GO TO 144                                              000081
      U=(U4(I,J)+U4(I-1,J))*.5                                           000082
      GO TO 154                                                          000083
144   U=(U4(I,J)+U4(I,J-1))*.5                                           000084
154   IF(U.GT.1000.) U=0.                                                000085
      SU4(I,J)=SU4(I,J)+U                                                000086
114   SZU4(I,J)=SZU4(I,J)+(H4(I,J)+Z4(I,J))*U                            000087
      DO 115 I=1,22                                                      000088
      DO 115 J=1,33                                                      000089
      IF(IV.EQ.2) GO TO 145                                              000090
      U=(U5(I,J)+U5(I-1,J))*.5                                           000091
      GO TO 155                                                          000092
145   U=(U5(I,J)+U5(I,J-1))*.5                                           000093
155   IF(U.GT.1000.) U=0.                                                000094
      SU5(I,J)=SU5(I,J)+U                                                000095
115   SZU5(I,J)=SZU5(I,J)+(H5(I,J)+Z5(I,J))*U                            000096
200   CONTINUE                                                           000097
C                                                                        000098
C        GET THE TIME AVERAGE OF THE SUMS                                000099
      DO 121 I=1,29                                                      000100
      DO 121 J=1,65                                                      000101
      SU1(I,J)=SU1(I,J)/48.                                              000102
121   SZU1(I,J)=SZU1(I,J)/48.                                            000103
      DO 122 I=1,15                                                      000104
      DO 122 J=1,28                                                      000105
      SU2(I,J)=SU2(I,J)/48.                                              000106
122   SZU2(I,J)=SZU2(I,J)/48.                                            000107
      DO 123 I=1,25                                                      000108
```

Table 6 (continued)

```
      DO 123 J=1,17                                                    000109
      SU3(I,J)=SU3(I,J)/48.                                            000110
123   SZU3(I,J)=SZU3(I,J)/48.                                          000111
      DO 124 I=1,25                                                    000112
      DO 124 J=1,24                                                    000113
      SU4(I,J)=SU4(I,J)/48.                                            000114
124   SZU4(I,J)=SZU4(I,J)/48.                                          000115
      DO 125 I=1,22                                                    000116
      DO 125 J=1,33                                                    000117
      SU5(I,J)=SU5(I,J)/48.                                            000118
125   SZU5(I,J)=SZU5(I,J)/48.                                          000119
C                                                                      000120
C        CALCULATE THE STOKES DRIFT                                    000121
      DO 131 I=1,29                                                    000122
      DO 131 J=1,65                                                    000123
131   U1(I,J)=SZU1(I,J)-H1(I,J)*SU1(I,J)                               000124
      DO 132 I=1,15                                                    000125
      DO 132 J=1,28                                                    000126
132   U2(I,J)=SZU2(I,J)-H2(I,J)*SU2(I,J)                               000127
      DO 133 I=1,25                                                    000128
      DO 133 J=1,17                                                    000129
133   U3(I,J)=SZU3(I,J)-H3(I J)*SU3(I,J)                               000130
      DO 134 I=1,25                                                    000131
      DO 134 J=1,24                                                    000132
134   U4(I,J)=SZU4(I,J)-H4(I,J)*SU4(I,J)                               000133
      DO 135 I=1,22                                                    000134
      DO 135 J=1,33                                                    000135
135   U5(I,J)=SZU5(I,J)-H5(I,J)*SU5(I,J)                               000136
C                                                                      000137
C        WRITE THE U / V COMPONENT OF THE STOKES DRIFT                 000138
      WRITE(11) U1,U2,U3,U4,U5                                         000139
210   CONTINUE                                                         000140
      STOP                                                             000141
      END                                                              000142
```

```
89    CONTINUE                                                         000342
-                                                                      -
******* INSERT AFTER LINE 342 *******                                  I
      U=YOU(IYE,JAY)                                                   I1
      V=VEE(IYE,JAY)                                                   I2
      GO TO 51                                                         I3
-                                                                      -
******* INSERT AFTER LINE 377 *******                                  I
      YH1=YUP+2.                                                       I
-                                                                      -
      CALL SYMBOL(XR,YH1,.15,6HCM/SEC,0.,6)                            000381
```

3.0 SPECIAL PURPOSE PLOTS

The programs contained within this section have been written to illustrate specific things. Each program is explained superficially by the use of comment cards. A short description explains in more detail the purpose and operation of each program. Following each description is a listing of the source program (and any inputs which may be required) and a sample plot.

3.1 OBSERVED TIDAL ELEVATIONS

Program GAUGE is designed to plot hourly tidal elevations for up to eight records simultaneously. The data are in standard hourly height format and are read by the program from the logical files named TAPE1 to TAPE8. TAPE12 is the unit onto which all plotter instructions are written.

It is necessary to supply a scaling factor for the whole plot and the number of data sets to be plotted. For each set, the starting hour, day and month as well as a label must be supplied. Scaling factors for the x and y axes, XSC and YSC respectively, are set within the program.

A listing of GAUGE as well as a sample plot follows.

3.2 WATER ELEVATION NEAR BARRIERS

1. General Description

The program to plot the elevation of the water in front of and behind a barrier and the mean elevation of the reservoir is stored on disc on file BKPROT. Input for this program must be supplied by a program to calculate these data. The program to do this is BKEPL and is virtually identical to Greenberg's DGEPL. The difference between the two is that DGEPL plots the data on the printer where BKEPL writes the data onto a scratch disc file, TAPE1, which is then used as input for BKPROT. Program BKEPL handles only the four barrier cases B6, B9, A6 and A8 for the extended model. Control cards for this program are stored on file BKJPROT. Listings of BKPROT and BKJPROT are supplied with this documentation.

2. Inputs Required

a) For BKEPL

i) a specification of the number of plots to be made and the number of points in each plot.

ii) a specification of the grid number and x,y coordinates of the point to be plotted and upper and lower limits. This must be repeated for each plot.

iii) to get the mean elevation in a reservoir the coordinates of the point are replaced by a code for the barrier case of interest. Thus:

B6 codes as 98
B9 codes as 99
A6 codes as 96
A8 codes as 97

All are read from input.

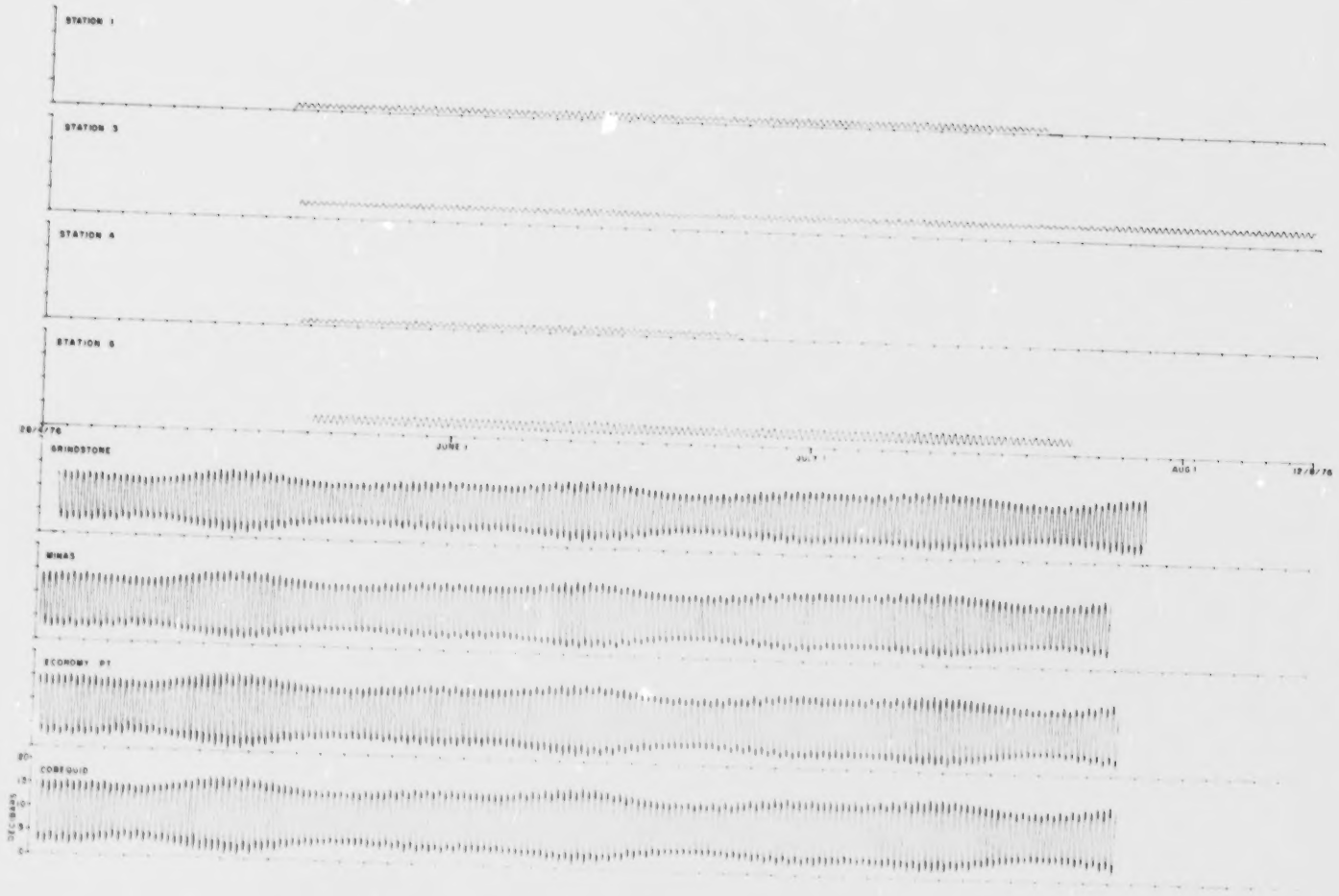

Figure 8

Sample plot of hourly tidal heights for the offshore gauges.

Table 7

The source listing of the program to plot the offshore tide gauge records.

```
      PROGRAM GAUGE(INPUT,OUTPUT,TAPE1,TAPE2,TAPE3,TAPE4,TAPE5,TAPE6,TAP      000001
     +E7,TAPE8,TAPE12)                                                        000002
C                                                                             000003
C        PROGRAM GAUGE TAKES A MAXIMUM OF 8 INPUTS OF DATA                    000004
C          AND PLOTS THEM ONE ABOVE THE OTHER.                                000005
      DIMENSION Y(3000),BUFF(1),IDAY(8),MONTH(8),IHOUR(8),ALAB(8)             000006
C                                                                             000007
C        INITIALIZE THE PLOT ROUTINES.                                        000008
      CALL PLOTS(BUFF,200,12)                                                 000009
      CALL PLOT(0.,-30.,-3)                                                   000010
      CALL PLOT(3.,5.,-3)                                                     000011
C                                                                             000012
C        READ THE SCALING FACTOR FOR THE PLOT, FAC, THE                       000013
C          NUMBER OF PLOTS TO BE MADE, NPLTS.                                 000014
      READ 100,FAC,NPLT,IBASE                                                 000015
100   FORMAT(F5.2,2I5)                                                        000016
C                                                                             000017
C        READ THE STARTING HOUR, DAY, MONTH AND A LABEL                       000018
C          FOR NPLT RECORDS AND ECHO PRINT THESE.                             000019
      DO 101 I=1,NPLT                                                         000020
      READ 102,IHOUR(I),IDAY(I),MONTH(I),ALAB(I)                              000021
102   FORMAT(3I5,A10)                                                         000022
      PRINT 105,IHOUR(I),IDAY(I),MONTH(I),ALAB(I)                             000023
105   FORMAT(* *,3I10,A20)                                                    000024
101   CONTINUE                                                                000025
      CALL FACTOR(FAC)                                                        000026
C                                                                             000027
C        SET THE Y COORDINATE OF THE ORIGIN OF THE FIRST                      000028
C          PLOT AND THE X AND Y SCALING FACTORS, XSC, YSC.                    000029
      YUP=27.                                                                 000030
      XSC=1./48.                                                              000031
      YSC=1./500.                                                             000032
      XMAX=0.                                                                 000033
      DO 900 NT=1,NPLT                                                        000034
      N1=1                                                                    000035
201   N2=N1+11                                                                000036
C                                                                             000037
C        READ THE DATA TO BE PLOTTED, PLOT IT, DRAW THE Y AXIS                000038
C          AND LABEL THE PLOT.                                                000039
      READ(NT,200)(Y(I),I=N1,N2)                                              000040
200   FORMAT(20X,12F4.0)                                                      000041
      IF(EOF(NT).NE.0) GO TO 202                                              000042
      N1=N1+12                                                                000043
      GO TO 201                                                               000044
202   CONTINUE                                                                000045
      KOUNT=N2-12                                                             000046
      PRINT 106,NT,KOUNT                                                      000047
106   FORMAT(* FOR TAPE*,I5,*   KOUNT=*,I5)                                   000048
      CALL AXIS(0.,YUP,1H ,1,48.,90.,0.,5.)                                   000049
      Y2=YUP+1.                                                               000050
      CALL SYMBOL(-1.,Y2,.21,ALAB(NT),90.,10)                                 000051
      XST=FLOAT(IDAY(NT)*24+IHOUR(NT))                                        000052
      KNT=1                                                                   000053
2     IF(Y(KNT).EQ.0..AND.Y(KNT+1).NE.0.) GO TO 1                             000054
      KNT=KNT+1                                                               000055
      GO TO 2                                                                 000056
1     X=XST*XSC                                                               000057
      WY=Y(KNT+1)*YSC+YUP                                                     000058
      CALL PLOT(X,WY,3)                                                       000059
      KNT=KNT+2                                                               000060
      DO 203 I=KNT,KOUNT                                                      000061
      XST=XST+1.                                                              000062
      X=XST*XSC                                                               000063
      IF(Y(I).EQ.0..AND.Y(I+1).EQ.0.) GO TO 3                                 000064
      WY=Y(I)*YSC+YUP                                                         000065
203   CALL PLOT(X,WY,2)                                                       000066
3     XMAX=AMAX1(XMAX,XST)                                                    000067
900   YUP=YUP-4.5                                                             000068
C                                                                             000069
C        DRAW THE X AXIS.                                                     000070
      YUP=27.                                                                 000071
      DO 901 NT=1,NPLT                                                        000072
      CALL PLOT(0.,YUP,3)                                                     000073
      HX=48.                                                                  000074
      Y1=YUP-.1                                                               000075
204   X=HX*XSC                                                                000076
      CALL PLOT(X,YUP,2)                                                      000077
      CALL PLOT(X,Y1,2)                                                       000078
      CALL PLOT(X,YUP,2)                                                      000079
      HX=HX+48.                                                               000080
      IF(HX.LE.XMAX) GO TO 204                                                000081
901   YUP=YUP-4.5                                                             000082
      CALL PLOT(0.,0.,999)                                                    000083
      STOP                                                                    000084
      END                                                                     000085
```

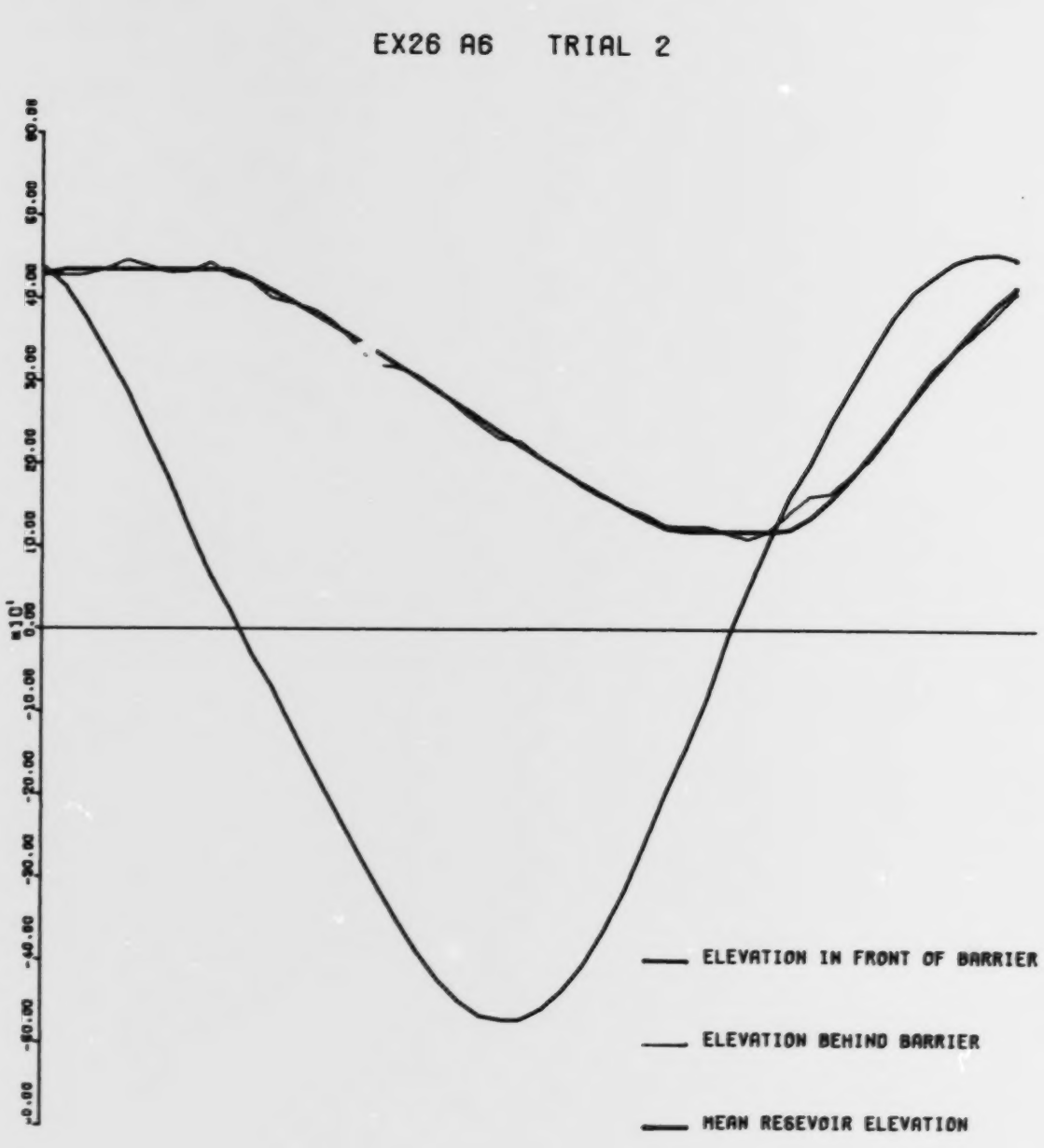

Figure 9

Sample plot of the elevations of the water behind and in front of a barrier and the mean reservoir elevation.

Table 8

The source listing of the program to plot the elevation behind and in front of a barrier and the mean reservoir elevation.

```
      PROGRAM PROT(INPUT,OUTPUT,TAPE1,TAPE10)                          000001
      DIMENSION Y(3,48),BUFF(1)                                        000002
      REWIND 1                                                         000003
C                                                                      000004
C         READ THE DATA                                                000005
      DO 102 I=1,3                                                     000006
      DO 100 J=1,48                                                    000007
100   READ(1,101) Y(I,J)                                               000008
101   FORMAT(E12.5)                                                    000009
      READ(1,101) X                                                    000010
102   READ(1,101) X                                                    000011
      CALL PLOTS(BUFF,200,10)                                          000012
      CALL PLOT(10.,-30.,-3)                                           000013
      CALL PLOT(3.,3.,-3)                                              000014
C                                                                      000015
C       READ THE PLOT SCALING FACTOR AND LABELS                        000016
      READ 103,FAC,TRIAL,ALABEL,ALAB2                                  000017
103   FORMAT(F6.2,3A10)                                                000018
      CALL FACTOR(FAC)                                                 000019
C                                                                      000020
C       PLOT THE Y AXIS                                                000021
      CALL AXIS(0.,0.,10HHEIGHT(CM),10,12.,90.,-600.,100.)             000022
C                                                                      000023
C       PLOT THE X AXIS                                                000024
      CALL PLOT(0.,6.,3)                                               000025
      CALL PLOT(12.,6.,2)                                              000026
      CALL PLOT(2.9,6.,3)                                              000027
      CALL PLOT(2.9,5.9,2)                                             000028
      CALL SYMBOL(2.9,5.7,.14,1H3,0.,1)                                000029
      CALL PLOT(5.8,6.,3)                                              000030
      CALL PLOT(5.8,5.9,2)                                             000031
      CALL SYMBOL(5.8,5.7,.14,1H6,0.,1)                                000032
      CALL PLOT(8.7,6.,3)                                              000033
      CALL PLOT(8.7,5.9,2)                                             000034
      CALL SYMBOL(8.7,5.7,.14,1H9,0.,1)                                000035
      CALL PLOT(11.59,6.,3)                                            000036
      CALL PLOT(11.59,5.9,2)                                           000037
      CALL SYMBOL(11.57,5.7,.14,2H12,0.,2)                             000038
      CALL SYMBOL(12.2,5.9,.14,5HHOURS,0.,5)                           000039
C                                                                      000040
C         PLOT THE DATA                                                000041
      DO 104 J=1,3                                                     000042
      IPEN=3                                                           000043
      XSC=.25                                                          000044
      X=0.                                                             000045
      YSC=.01                                                          000046
      YUP=6.                                                           000047
      PRINT 105,J                                                      000048
105   FORMAT(* PLOTTING NUMBER *,I5)                                   000049
      PRINT 107,(Y(J,I),I=1,48)                                        000050
107   FORMAT(* *,8F10.2)                                               000051
      DO 104 I=1,48                                                    000052
      CALL NEWPEN(J)                                                   000053
      EX=X*XSC                                                         000054
      EY=Y(J,I)*YSC+YUP                                                000055
      CALL PLOT(EX,EY,IPEN)                                            000056
      X=X+1.                                                           000057
104   IPEN=2                                                           000058
      PRINT 106                                                        000059
106   FORMAT(* PLOTS COMPLETED*)                                       000060
C                                                                      000061
C         LABEL THE PLOTS                                              000062
      CALL NEWPEN(1)                                                   000063
      CALL SYMBOL(4.0,13.,.21,TRIAL,0.,10)                             000064
      CALL SYMBOL(6.2,13.,.21,ALABEL,0.,10)                            000065
      CALL SYMBOL(8.5,13.,.21,ALAB2,0.,10)                             000066
      CALL SYMBOL(8.0,2.0,.14,10HELEVATION ,0.,10)                     000067
      CALL SYMBOL(9.4,2.0,.14,10HIN FRONT O,0.,10)                     000068
      CALL SYMBOL(10.8,2.0,.14,10HF BARRIER ,0.,10)                    000069
      CALL SYMBOL(8.0,1.0,.14,10HELEVATION ,0.,10)                     000070
      CALL SYMBOL(9.4,1.0,.14,10HBEHIND BAR,0.,10)                     000071
      CALL SYMBOL(10.8,1.0,.14,4HRIER,0.,4)                            000072
      CALL SYMBOL(8.0,0.,.14,10HMEAN RESEV,0.,10)                      000073
      CALL SYMBOL(9.4,0.,.14,10HOIR ELEVAT,0.,10)                      000074
      CALL SYMBOL(10.8,0.,.14,3HION,0.,3)                              000075
      CALL PLOT(7.25,1.0,3)                                            000076
      CALL PLOT(7.75,1.0,2)                                            000077
      CALL NEWPEN(2)                                                   000078
      CALL PLOT(7.25,2.0,3)                                            000079
      CALL PLOT(7.75,2.0,2)                                            000080
      CALL NEWPEN(3)                                                   000081
      CALL PLOT(7.25,0.0,3)                                            000082
      CALL PLOT(7.75,0.0,2)                                            000083
      CALL PLOT(0.,0.,999)                                             000084
      STOP                                                             000085
      END                                                              000086
```

Table 8 (continued)

```
ILVBK,CM110000,T100,MT1,IO150,P2.  BOB KEELEY                                   000001
ACCOUNT,*****.                                                                  000002
ATTACH,A,BKEPL,ID=MEDS.                                                         000003
LABEL,TAPE15,R,L=DG2WB9T5,T=999,X=SV.ER2382                                     000004
FTN,I=A,L=0.                                                                    000005
LGO.                                                                            000006
UNLOAD,TAPE15.                                                                  000007
RETURN,LGO,TAPE15,A.                                                            000008
ATTACH,A,BKPROT,ID=MEDS.                                                        000009
FTN,I=A,L=0.                                                                    000010
ATTACH,LIB,MEDSPLIB,ID=MEDSPLIB,MR=1.                                           000011
LIBRARY,LIB.                                                                    000012
REQUEST,TAPE10,HY,S,SV,MT,MOUNT OCEANPLOT TAPE RETURN KEELEY STOP 1             000013
LGO.                                                                            000014
      3    48                                                                   000015
      1    10    25 600.-600.                                                  000016
      1    10    26 600.-600.                                                  000017
      1    99    99 600.-600.                                                  000018
    .602 WAY GENERATION 89                                                      000019
                                                                                000021
```

b) For BKPROT

i) specification of the scaling factor for the whole plot, and labels for the plot are required. These are read from input.

ii) TAPE1. This is the output tape from BKEPL. It contains the data formated with one point per record. The last two points are the specified upper and lower limits and so are not plotted.

3. Output Generated

a) BKEPL echo prints the input variables.

b) BKPROT lists all the data to be used in each plot.

c) TAPE 10 this is the output tape on which the plotter instructions are written.

4. Arrays

a) Y(I,J) contains the data to be plotted

I = the plot number
J = the data point number

b) BUFF(I) an array specifying the size of the buffer for the plotter.

5. Variables

a) X has two uses. At first it is just a dummy variable to read the last two data points in each plot. Later it is used as a counter for the position, on the x-axis of the point being plotted.

b) FAC: this is the scaling factor for the whole plot and is read from input.

c) TRIAL, ALABEL: labels for the plot. ALABEL is the trial number and TRIAL is the plot label.

d) IPEN: pen instruction for the plotting of each point.

e) XSC, YSC: x and y scaling factors for the plot.

f) YUP: vertical position of the x-axis with respect to the plotter origin.

g) EX,EY: scaled x and y coordinates of the point being plotted.

3.3 MODEL VERSUS OBSERVED TIDAL AMPLITUDES AND PHASES

Separate programs are required to plot the amplitude and phase. The program to plot the amplitude is CPARA. The data for this plot is stored on disc. The form of the input is in integer pairs of observed, IXO, and model, IXM, amplitudes. The number of pairs, NUMBER, is read from input.

The program to plot the phase is called CPARP and is virtually identical to CPARA. The exception is that because phases between 20° and 230° are absent in the data any phases between 0 and 20° are augmented by 360° to provide a more uniform presentation of the data. Source listings and sample plots follow.

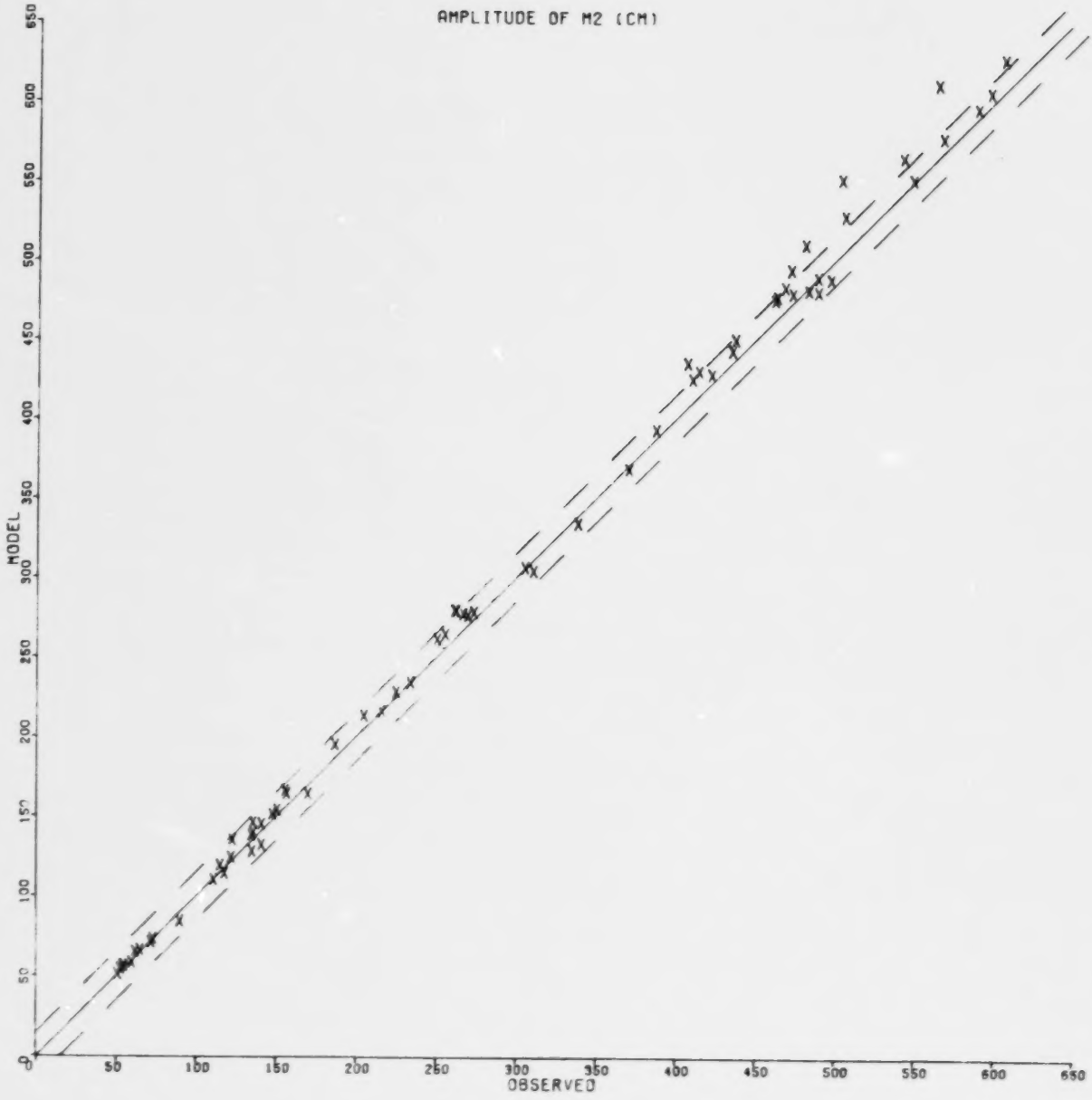

Figure 10a

Sample plots of the comparison of observed and model predictions of the amplitude (a) and phase (b) of M2 at selected ports in the Bay of Fundy.

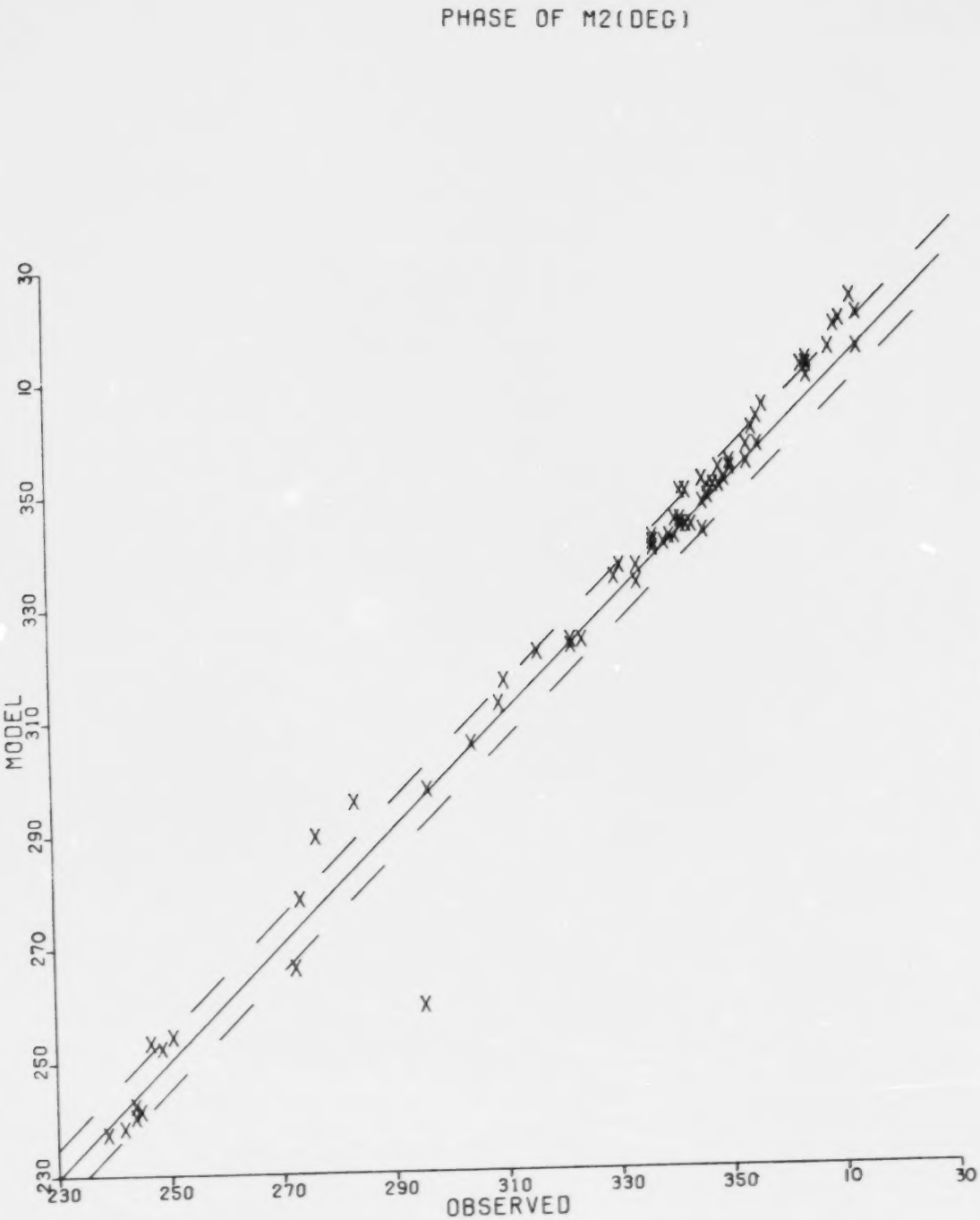
PHASE OF M2(DEG)
MODEL
230
250
270
290
310
330
350
10
30
OBSERVED

Figure 10b

Table 9

The source listing of the program to plot the comparison of model and observed amplitudes and phases of M2.

```
      PROGRAM CPARA(INPUT,OUTPUT,TAPE1,TAPE2)                          000001
C                                                                      000002
C          THIS PROGRAM PLOTS THE COMPARISON OF THE AMPLITUDES FOR      000003
C           PORTS ALONG THE BAY OF FUNDY. AMPLITUDES COMPUTED FROM      000004
C           THE BAY OF FUNDY MODEL ARE PLOTTED AGAINST THE OBSERVED     000005
C           VALUES.                                                    000006
      DIMENSION IXO(100),IXM(100),BUFF(1)                              000007
      REWIND 1                                                         000008
C                                                                      000009
C          READ THE NUMBER OF PORTS FOR WHICH AMPLITUDES ARE TO        000010
C           BE COMPARED.                                               000011
      READ(1,100) NUMBER                                               000012
100   FORMAT(I5)                                                       000013
C                                                                      000014
C          READ AND ECHO PRINT THE DATA.                               000015
      READ(1,101)(IXO(I),IXM(I),I=1,NUMBER)                            000016
101   FORMAT(2I5)                                                      000017
      PRINT 102,(IXO(I),IXM(I),I=1,NUMBER)                             000018
102   FORMAT(* *,5(5X,2I5))                                            000019
C                                                                      000020
C          INITIALIZE THE PLOT ROUTINES.                               000021
      CALL PLOTS(BUFF,200,2)                                           000022
      CALL PLOT(0.,-30.,-3)                                            000023
      CALL PLOT(3.,3.,-3)                                              000024
C                                                                      000025
C          DRAW AND LABEL THE AXES.                                    000026
      CALL AXIS(0.,0.,8HOBSERVED,-8,13.,0.,0.,50.)                     000027
      CALL AXIS(0.,0.,5HMODEL,5,13.,90.,0.,50.)                        000028
C                                                                      000029
C          SET THE SCALING FACTOR 1 INCH = 50 CM AND PLOT              000030
C           ALL THE DATA.                                              000031
      SC=12./600.                                                      000032
      DO 500 I=1,NUMBER                                                000033
      EX=SC*IXO(I)                                                     000034
      EY=SC*IXM(I)                                                     000035
C                                                                      000036
C          PLOT AN X FOR EACH POINT.                                   000037
      CALL SYMBOL(EX,EY,.14,1HX,0.,1)                                  000038
500   CONTINUE                                                         000039
C                                                                      000040
C          LABEL THE PLOT.                                             000041
      CALL SYMBOL(5.,13.,.14,10HAMPLITUDE ,0.,10)                      000042
      CALL SYMBOL(6.4,13.,.14,10HOF M2 (CM),0.,10)                     000043
      CALL PLOT(0.,0.,3)                                               000044
      CALL PLOT(13.,13.,2)                                             000045
      IFLAG=1                                                          000046
C                                                                      000047
C          DRAW A STRAIGHT LINE WHERE MODEL = OBSEVED DATA.            000048
      X=0.                                                             000049
      Y=15.*SC                                                         000050
      DX=.3                                                            000051
      DY=.3                                                            000052
1     CALL PLOT(X,Y,3)                                                 000053
C                                                                      000054
C          PLOT DASHED LINES +/- 5 CM ON EITHER SIDE OF THE            000055
C           STRAIGHT LINE.                                             000056
      X=X+DX                                                           000057
      Y=Y+DY                                                           000058
      CALL PLOT(X,Y,2)                                                 000059
      X=X+DX                                                           000060
      Y=Y+DY                                                           000061
      IF(X.LT.13.) GO TO 1                                             000062
      IF(IFLAG.EQ.2) GO TO 99                                          000063
      IFLAG=2                                                          000064
      X=15.*SC                                                         000065
      Y=0.                                                             000066
      GO TO 1                                                          000067
C                                                                      000068
C          TERMINATE THE PLOT ROUTINE.                                 000069
99    CALL PLOT(0.,0.,999)                                             000070
      STOP                                                             000071
      END                                                              000072
```

Table 9 (continued)

```
      PROGRAM CPARP(INPUT,OUTPUT,TAPE1,TAPE2)                                   000001
C                                                                               000002
C           THIS PROGRAM PLOTS THE COMPARISON OF PHASES FOR SPECIFIC            000003
C            PORTS ALONG THE BAY OF FUNDY. PHASES COMPUTED FROM THE             000004
C            BAY OF FUNDY MODEL ARE PLOTTED AGAINST OBSERVED VALUES.            000005
      DIMENSION IXO(100),IXM(100),BUFF(1)                                       000006
      REWIND 1                                                                  000007
C                                                                               000008
C           READ THE NUMBER OF PORTS FOR WHICH COMPARISONS ARE TO               000009
C            BE MADE.                                                           000010
      READ(1,100) NUMBER                                                        000011
100   FORMAT(I5)                                                                000012
C                                                                               000013
C           READ AND ECHO PRINT THE DATA.                                       000014
      READ(1,101)(IXO(I),IXM(I),I=1,NUMBER)                                     000015
101   FORMAT(2I5)                                                               000016
      PRINT 102,(IXO(I),IXM(I),I=1,NUMBER)                                      000017
102   FORMAT(* *,5(5X,2I5))                                                     000018
C                                                                               000019
C           INITIALIZE THE PLOT ROUTINES.                                       000020
      CALL PLOTS(BUFF,200,2)                                                    000021
      CALL PLOT(0.,-30.,-3)                                                     000022
      CALL PLOT(3.,3.,-3)                                                       000023
C                                                                               000024
C           SET THE SCALING FACTOR FOR THE WHOLE PLOT.                          000025
      CALL FACTOR(1.5)                                                          000026
C                                                                               000027
C           PLOT AND LABEL THE AXES.                                            000028
      CALL AXIS(0.,0.,8HOBSERVED,-8,8.,0.,230.,20.)                             000029
      CALL AXIS(0.,0.,5HMODEL,5,8.,90.,230.,20.)                                000030
C                                                                               000031
C           SET THE SCALING FACTOR 1 INCH = 20 DEGREES AND PLOT                 000032
C            ALL THE DATA.                                                      000033
      SC=8./160.                                                                000034
      DO 500 I=1,NUMBER                                                         000035
C                                                                               000036
C           IF THE DATA POINT IS LESS THAN 230 DEGREES ADD 360 DEGREES.         000037
      IF(IXO(I).LT.230) IXO(I)=IXO(I)+360                                       000038
      IF(IXM(I).LT.230) IXM(I)=IXM(I)+360                                       000039
      EX=SC*(IXO(I)-230)                                                        000040
      EY=SC*(IXM(I)-230)                                                        000041
C                                                                               000042
C           PLOT AN X FOR EACH DATA POINT.                                      000043
      CALL SYMBOL(EX,EY,.14,1HX,0.,1)                                           000044
500   CONTINUE                                                                  000045
C                                                                               000046
C           LABEL THE PLOT.                                                     000047
      CALL SYMBOL(5.,13.,.14,5HPHASE,0.,5)                                      000048
      CALL SYMBOL(5.84,13.,.14,10HOF M2(DEG),0.,10)                             000049
C                                                                               000050
C           DRAW A STRAIGHT LINE CORRESPONDING TO MODEL = OBSERVED DATA.        000051
      CALL PLOT(0.,0.,3)                                                        000052
      CALL PLOT(8.,8.,2)                                                        000053
C                                                                               000054
C          PLOT DASHED LINES +/- 5 DEGREES ON EITHER SIDE OF THE                000055
C           STRAIGHT LINE.                                                      000056
      IFLAG=1                                                                   000057
      X=0.                                                                      000058
      Y=5.*SC                                                                   000059
      DX=.3                                                                     000060
      DY=.3                                                                     000061
1     CALL PLOT(X,Y,3)                                                          000062
      X=X+DX                                                                    000063
      Y=Y+DY                                                                    000064
      CALL PLOT(X,Y,2)                                                          000065
      X=X+DX                                                                    000066
      Y=Y+DY                                                                    000067
      IF(X.LT.8.) GO TO 1                                                       000068
      IF(IFLAG.EQ.2) GO TO 99                                                   000069
      IFLAG=2                                                                   000070
      X=5.*SC                                                                   000071
      Y=0.                                                                      000072
      GO TO 1                                                                   000073
C                                                                               000074
C           TERMINATE THE PLOT ROUTINES.                                        000075
99    CALL PLOT(0.,0.,999)                                                      000076
      STOP                                                                      000077
      END                                                                       000078
```

3.4 MODEL PREDICTED CHANGES IN SHORELINE TIDAL ELEVATIONS FOR SELECTED BARRIERS

This program plots the amplitude change and the percent change in the tide along the Nova Scotia and New Brunswick shores for the barriers B6, B9, A6, A8. The data comes from Greenberg's extended model. The program is stored as file BKLVTN.

Data is read from TAPE1 and input. TAPE1 is the data stored on file BKS2SHORDAT and contains the amplitudes for the natural regime and the four barrier cases in 5I5 format. The first 92 rows is the data for the N.S. side and the next 88 rows is the data for the N.B. side.

Input contains data for the barrier case wanted:

NBAR = 2 for B6
NBAR = 3 for B9
NBAR = 4 for A8
NBAR = 5 for A6
NBAR = 99999 to stop the program

IPLOT = 1 for the amplitude change in centimeters
IPLOT = 2 for the percent amplitude change

FAC is the factor by which the whole plot is scaled

The included map shows darkened squares from which the amplitude data was recorded. X's mark reference cities used to label the plot.

3.5 COMPARATIVE TIDAL RESIDUALS

There can be two uses at least for this program. In the enclosed source listing, the program has been used to plot two tidal elevation curves, one from observed data and one from model results. These curves are superimposed to illustrate the success of the model in reproducing the existing tidal regime. Mean values for the two tidal sets (the ZO value in an harmonic analysis) as well as a labe for the plot are read from input. Data is read from disc.

With an alteration in the expression for the array R(J) residuals may be plotted. These may be superimposed or a new axis plotted and the residuals plotted on the new axis. If residuals are plotted, the value of YMEAN2 is irrelevant.

3.6 TERMS IN THE EQUATIONS OF MOTION

The programs in this section are broken into two parts. The first calculates individual terms in the equation of continuity. The second part, calculates the terms in the equation expressing conservation of momentum for either the u, or v component. Plots are labelled appropriately to distinguish them. All terms are plotted on identical vertical scales so that comparisons are simple. The term labelled as the sum for conservation of momentum is the sum of Coriolis, friction and surface slope terms.

3.6.1 The Continuity Equation

Program MFLUX calculates and plots the steady terms in the equation of continuity.

$$\frac{\partial}{\partial x}(h + Z)u \quad + \quad \frac{\partial}{\partial y}(h + Z)v$$

Table 10

The source listing of the program to plot M2 amplitudes along the Nova Scotia and New Brunswick shorelines.

```
      PROGRAM ELEV(INPUT,OUTPUT,TAPE1,TAPE10)                                   000001
      DIMENSION BUFF(1),XL(24),YL(24),LABEL(24),IY(2,7,110),LBAR(6)             000002
      DATA LBAR/4HA6B9,4HA8B9,6HA6A8B9,4HA6A8,4HA6B6,4HA8B6/                    000003
      DATA LABEL/10HBLOCK ISL.,10HPROVIDENCE,10HNEW BEDFRD,10HHYANNIS           000004
     +,10HC. COD    ,10HBOSTON    ,10HPORTLAND  ,10HBAR HBR.  ,10HEASTPO       000005
     +RT  ,10HST. JOHN  ,10HC. ENRAGE ,10HGRINDSTONE,10HLUNENBURG ,10HLI       000006
     +VERPOOL ,10HLOCKPORT  ,10HC. SABLE  ,10HYARMOUTH  ,10HWESTPORT  ,1       000007
     +0HCENTRVILLE,10HMARGRTSVLL,10HC. D OR   ,10HC BLOMIDON,10HFIVE ISL       000008
     +. ,10HBRNCOAT HD/                                                        000009
      DATA XL/1.,3.,5.,7.,10.,14.,21.,29.,38.,48.,78.,87.,24.,26.,28.,30       000010
     +.,33.,38.,42.,56.,69.,85.,96.,111./                                      000011
      DATA YL/12.,12.,12.,12.,12.,12.,12.,12.,12.,12.,12.,12.,0.,0.,0.         000012
     +,0.,0.,0.,0.,0.,0.,0.,0./                                                000013
      CALL PLOTS(BUFF,200,10)                                                   000014
      KNT=1                                                                     000015
C                                                                               000016
C       POSITION THE PLOT                                                       000017
131   CALL PLOT(10.,-30.,-3)                                                    000018
      CALL PLOT(3.,3.,-3)                                                       000019
C                                                                               000020
C          READ BARRIER WANTED,PLOT WANTED AND SCALING FACTOR                   000021
      READ 500,NBAR,IPLOT,FAC                                                   000022
      IF(NBAR.EQ.99999) GO TO 130                                               000023
500   FORMAT(2I5,F4.2)                                                          000024
      CALL FACTOR(FAC)                                                          000025
      IF(KNT.EQ.2) GO TO 132                                                    000026
C                                                                               000027
C          READ AMPLITUDE DATA                                                  000028
      DO 100 I=1,92                                                             000029
100   READ(1,501)(IY(1,J,I),J=1,7)                                              000030
501   FORMAT(7I5)                                                               000031
      DO 101 I=1,88                                                             000032
101   READ(1,501)(IY(2,J,I),J=1,7)                                              000033
132   IF(IPLOT.EQ.2) GO TO 600                                                  000034
C                                                                               000035
C       PLOT CM CHANGES                                                         000036
      CALL AXIS(0.,0.,1H ,1,11.,90.,-60.,10.)                                   000037
      CALL PLOT(0.,6.,3)                                                        000038
      CALL PLOT(12.,6.,2)                                                       000039
      XSC=.1                                                                    000040
      YSC=.1                                                                    000041
      YUP=6.                                                                    000042
      IPEN=3                                                                    000043
      CALL NEWPEN(1)                                                            000044
      DO 102 I=1,92                                                             000045
      J=93-I                                                                    000046
      X=FLOAT(I+23)*XSC                                                         000047
      EY=FLOAT(IY(1,NBAR,J)-IY(1,1,J))                                          000048
      IF(IY(1,NBAR,J).EQ.0) GO TO 103                                           000049
      Y=EY*YSC+YUP                                                              000050
      CALL PLOT(X,Y,IPEN)                                                       000051
102   IPEN=2                                                                    000052
103   CALL NEWPEN(2)                                                            000053
      IPEN=3                                                                    000054
      DO 104 I=1,88                                                             000055
      J=89-I                                                                    000056
      X=FLOAT(I)*XSC                                                            000057
      EY=FLOAT(IY(2,NBAR,J)-IY(2,1,J))                                          000058
      Y=EY*YSC+YUP                                                              000059
      CALL PLOT(X,Y,IPEN)                                                       000060
104   IPEN=2                                                                    000061
      CALL NEWPEN(1)                                                            000062
      CALL SYMBOL(5.1,14.,.21,10HCHANGE(CM),0.,10)                              000063
      GO TO 999                                                                 000064
C                                                                               000065
C       PLOT PER CENT CHANGE                                                    000066
600   CALL AXIS(0.,0.,1H ,1,11.,90.,-25.,5.)                                    000067
      CALL PLOT(0.,5.,3)                                                        000068
      CALL PLOT(12.,5.,2)                                                       000069
      XSC=.1                                                                    000070
      YSC=.2                                                                    000071
      YUP=5.                                                                    000072
      IPEN=3                                                                    000073
      CALL NEWPEN(1)                                                            000074
      DO 110 I=1,92                                                             000075
      J=93-I                                                                    000076
      X=FLOAT(I+23)*XSC                                                         000077
      EY=FLOAT(IY(1,NBAR,J)-IY(1,1,J))/FLOAT(IY(1,1,J))                         000078
      IF(IY(1,NBAR,J).EQ.0) GO TO 111                                           000079
      Y=EY*YSC*100.+YUP                                                         000080
      CALL PLOT(X,Y,IPEN)                                                       000081
110   IPEN=2                                                                    000082
111   CALL NEWPEN(2)                                                            000083
      IPEN=3                                                                    000084
      DO 112 I=1,88                                                             000085
      J=89-I                                                                    000086
      X=FLOAT(I)*XSC                                                            000087
      EY=FLOAT(IY(2,NBAR,J)-IY(2,1,J))/FLOAT(IY(2,1,J))                         000088
      Y=EY*YSC*100.+YUP                                                         000089
      CALL PLOT(X,Y,IPEN)                                                       000090
112   IPEN=2                                                                    000091
      CALL NEWPEN(1)                                                            000092
      CALL SYMBOL(5.1,14.,.21,10HCHANGE (PE,0.,10)                              000093
      CALL SYMBOL(7.2,14.,.21,6HRCENT),0.,6)                                    000094
C                                                                               000095
C       LABEL THE PLOT                                                          000096
999   DO 120 I=1,24                                                             000097
      HX=XL(I)*XSC                                                              000098
```

Table 10 (continued)

```
120   CALL SYMBOL(HX,YL(I),.14,LABEL(I),90.,10)                    000099
      CALL SYMBOL(3.,14.,.21,10HAMPLITUDE ,0.,10)                  000100
      CALL SYMBOL(9.,14.,.21,LBAR(NBAR-1),0.,6)                    000101
      CALL SYMBOL'5.,11.,.21,10HPHASE 1 ST,0.,10)                  000102
      CALL SYMBOL(7.1,11.,.21,10HAGE 2 CALC,0.,10)                 000103
      CALL SYMBOL(9.2,11.,.21,7HULATION,0.,7)                      000104
      CAL' PLOT(9.,10.,3)                                          000105
      CALL PLOT(9.5,10.,2)                                         000106
      CALL SYMBOL(10.,10.,.14,9HN.S. SIDE,0.,9)                    000107
      CALL NEWPEN(2)                                               000108
      CALL PLOT(9.,9.5,3)                                          000109
      CALL PLOT(9.5,9.5,2)                                         000110
      CALL NEWPEN(1)                                               000111
      CALL SYMBOL(10.,9.5,.14,9HN.B. SIDE,0.,9)                    000112
      KNT=2                                                        000113
      GO TO 131                                                    000114
130   CALL PLOT(0.,0.,999)                                         000115
      STOP                                                         000116
      END                                                          000117
```

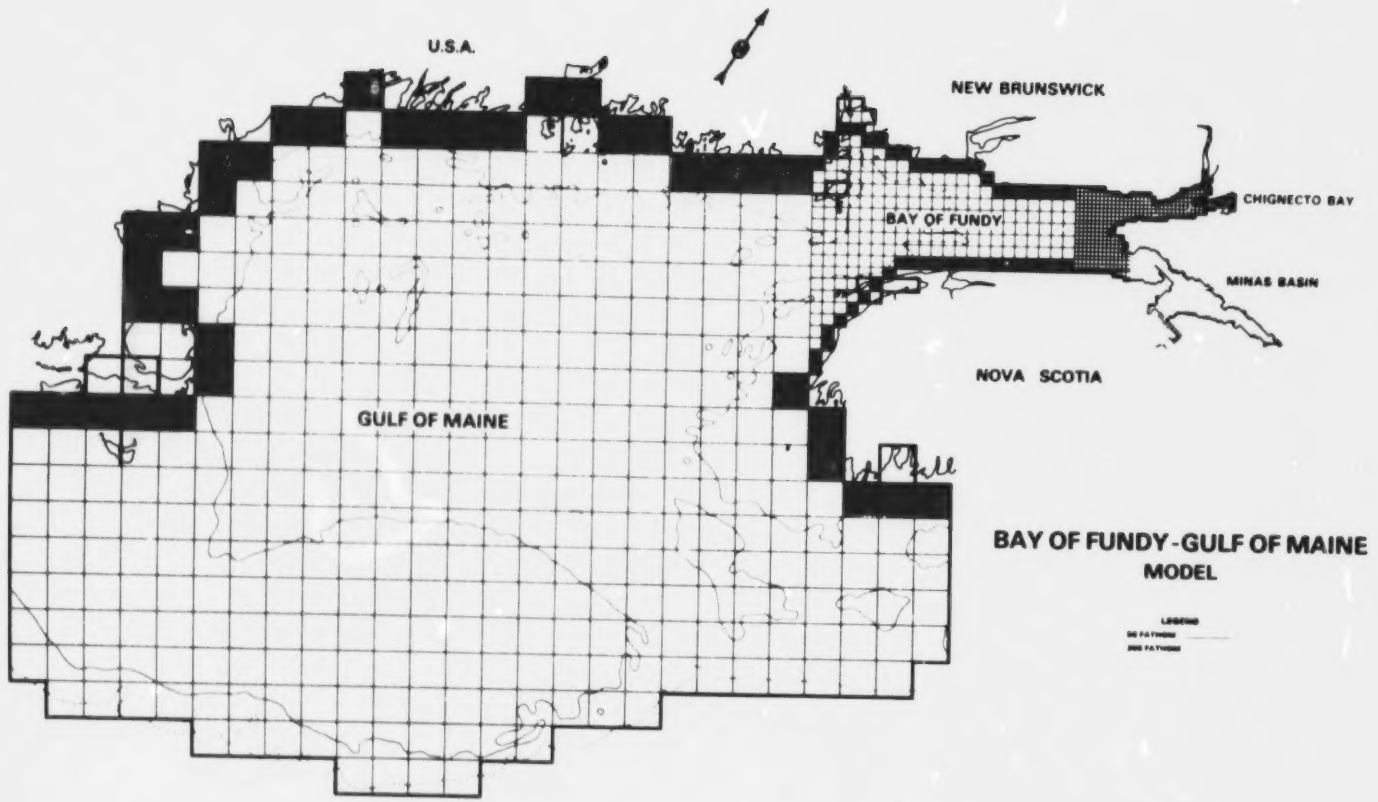

Figure 11a

Map of the model grids showing the tracks along the Nova Scotia and New Brunswick shores for which tidal amplitudes were compared.

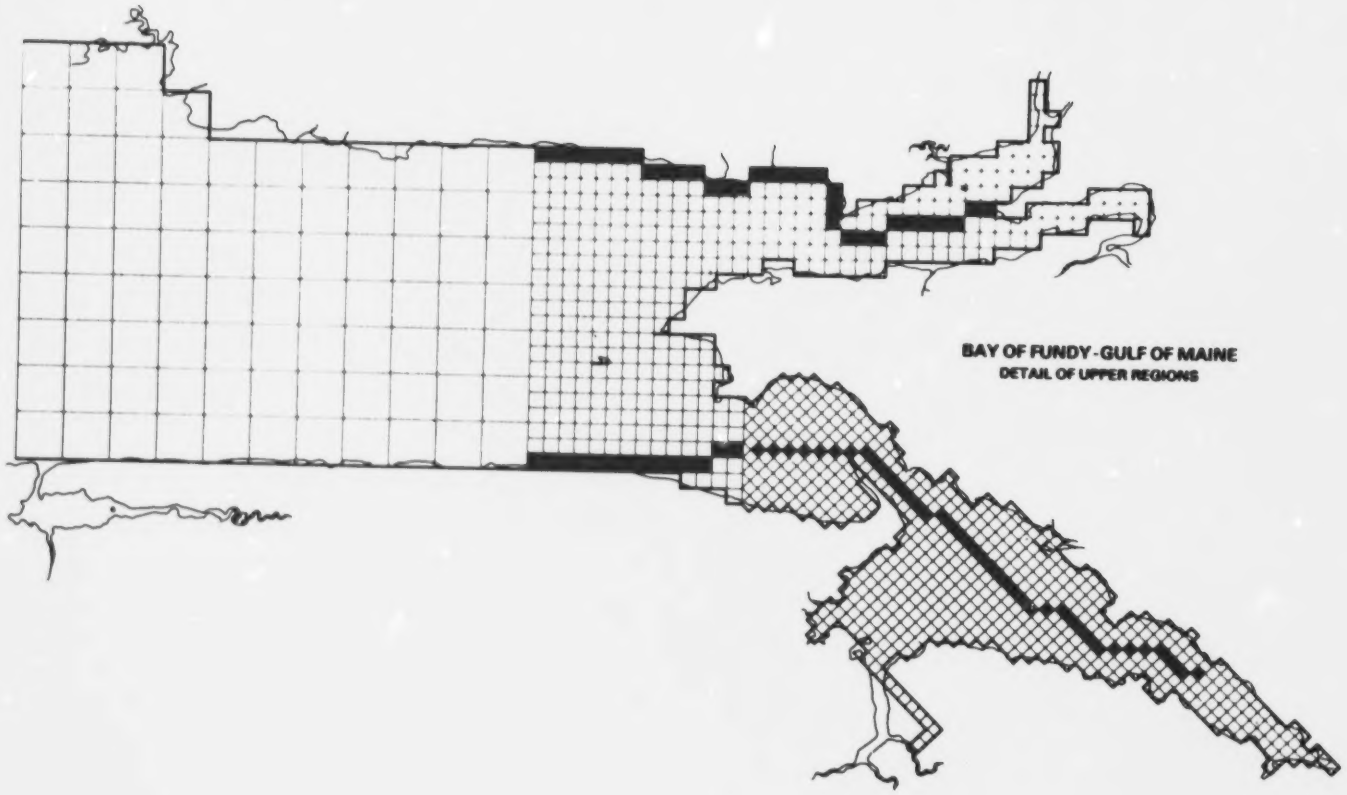

Figure 11b

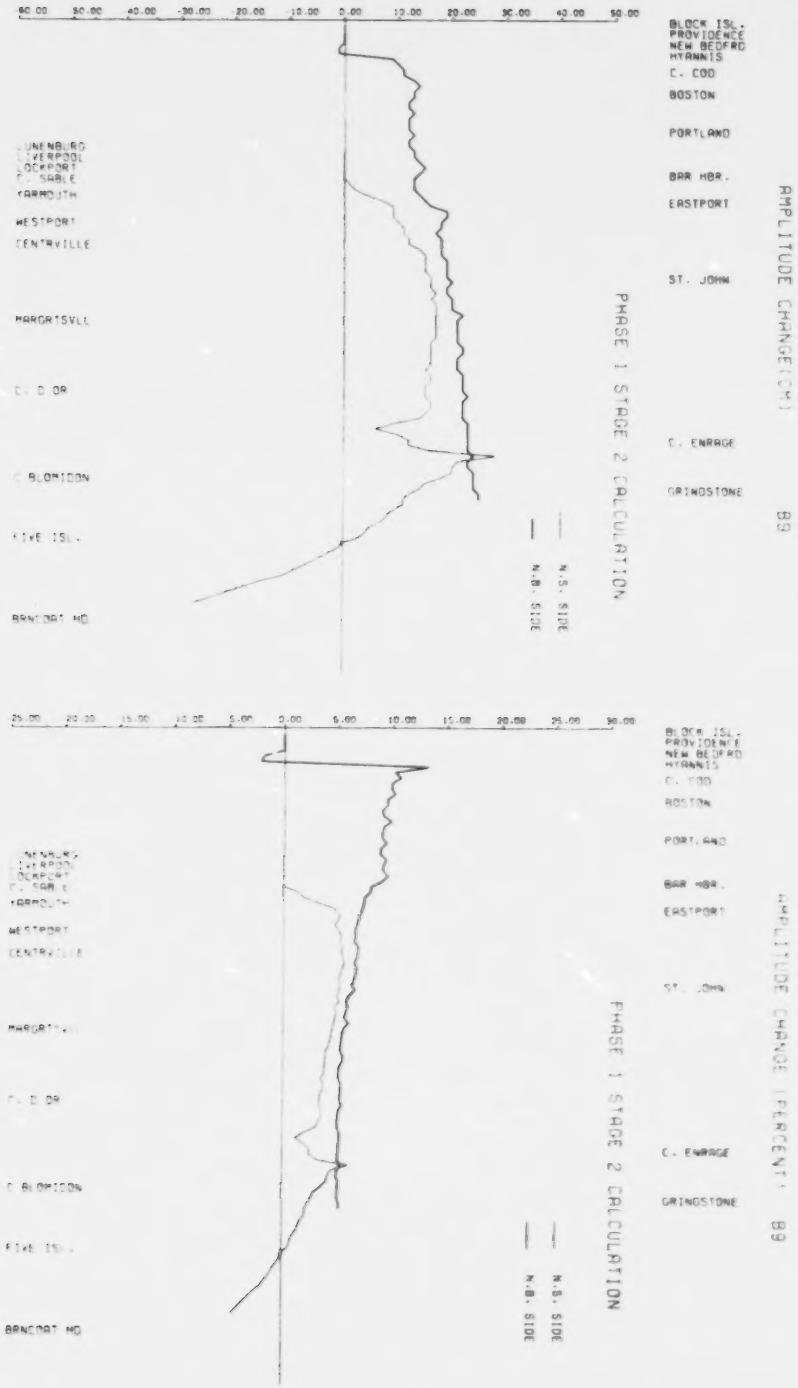

Figure 12

Sample plot of the tidal amplitude along the Nova Scotia and New Brunswick shores.

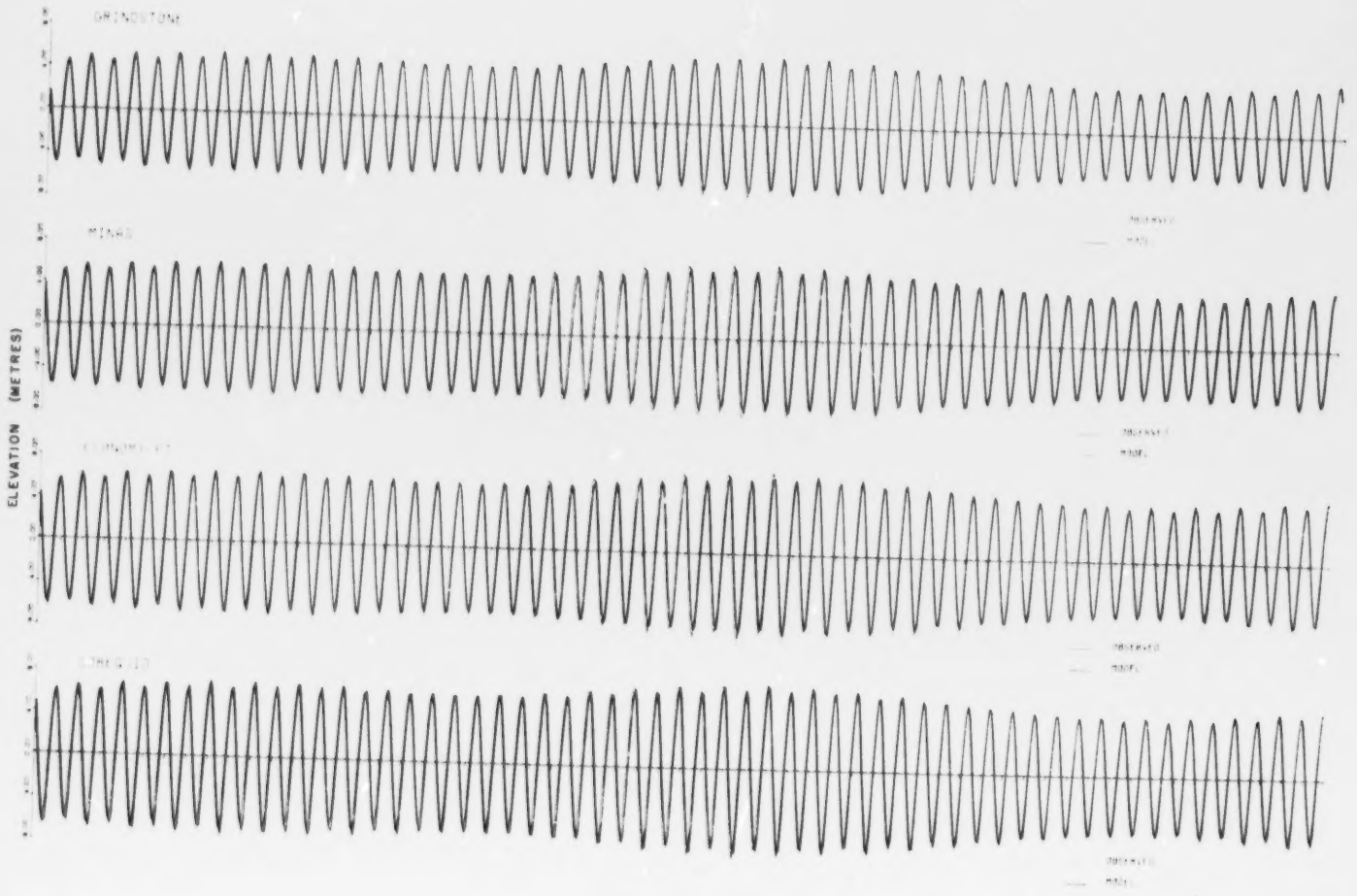

Figure 13

Sample plot of the comparison of model and observed tides.

Table 11

The source listing of the program to overlap plots of observed and predicted tides.

```
      PROGRAM PROT(INPUT,OUTPUT,TAPE1,TAPE2,TAPE10)                          000001
C                                                                            000002
C        THIS PROGRAM READS THE HOURLY TIDAL ELEVATIONS ON TAPES             000003
C         1 AND 2 AND PLOTS THEM WITH 2 DIFFERENT PENS ON                    000004
C          THE SAME AXES.                                                    000005
      DIMENSION IY(2,12),R(3000),BUFF(1)                                     000006
C                                                                            000007
C        INITIALIZE THE PLOT ROUTINES.                                       000008
      CALL PLOTS(BUFF,200,10)                                                000009
      CALL PLOT(0.,-30.,-3)                                                  000010
C                                                                            000011
C        SET THE ORIGIN 3.5 INCHES FROM THE BOTTOM OF THE PAPER              000012
C         THE Y SCALE IS 1 INCH = .5 METERS. THE X SCALE                     000013
C         IS 1 INCH = 12 HOURS. THE MEAN IS REMOVED FROM BOTH DATA SETS.     000014
      CALL PLOT(3.,3.,-3)                                                    000015
      READ 104,YMEAN1,YMEAN2,ALAB                                            000016
104   FORMAT(2F10.4,A10)                                                     000017
      XSC=1./24.                                                             000018
      YSC=.25                                                                000019
      EX=0.                                                                  000020
      YUP=2.                                                                 000021
      IPEN=3                                                                 000022
C                                                                            000023
C        PLOT THE Y AXIS AND LABEL                                           000024
      CALL AXIS(0.,0.,1H ,1,4.,90.,-8.,4.)                                   000025
      CALL SYMBOL(-1.,2.,.14,9HELEVATION,90.,9)                              000026
      CALL SYMBOL(-1.,3.4,.14,8H(METERS),90.,8)                              000027
      CALL SYMBOL(1.,4.,.21,ALAB,0.,10)                                      000028
      IT=0                                                                   000029
C                                                                            000030
C        READ THE DATA 12 POINTS AT A TIME                                   000031
1     READ(1,100)(IY(1,I),I=1,12)                                            000032
      READ(2,100)(IY(2,I),I=1,12)                                            000033
100   FORMAT(20X,12I4)                                                       000034
      IF(EOF(1).EQ.0.AND.EOF(2).EQ.0) GO TO 10                               000035
      IF(EOF(1).NE.0.AND.EOF(2).NE.0) GO TO 36                               000036
101   FORMAT(* NORMAL EOF FOUND*)                                            000037
      IF(EOF(1).EQ.0.AND.EOF(2).NE.0) PRINT 102                              000038
102   FORMAT(* EOF FOUND TAPE2*)                                             000039
      IF(EOF(1).NE.0.AND.EOF(2).EQ.0) PRINT 103                              000040
103   FORMAT(* EOF FOUND TAPE1*)                                             000041
      GO TO 36                                                               000042
10    CONTINUE                                                               000043
C                                                                            000044
C        STORE THE DATA FROM TAPE2 IN ARRAY R BUT PLOT TAPE 1 DATA           000045
C         IMMEDIATELY. IF RESIDUALS ARE DESIRED, R(J) MAY BE SET EQUAL       000046
C          THE DIFFERENCE OF IY(1, ) AND IY(2, ). PLOT ALL OF TAPE 1 NOW     000047
      DO 200 I=1,12                                                          000048
      J=I+IT                                                                 000049
      R(J)=FLOAT(IY(2,I))/100.-YMEAN2                                        000050
      X=XSC*EX                                                               000051
      Y=(FLOAT(IY(1,I))/100.-YMEAN1)*YSC+YUP                                 000052
      CALL PLOT(X,Y,IPEN)                                                    000053
      EX=EX+1.                                                               000054
200   IPEN=2                                                                 000055
      IT=IT+12                                                               000056
      GO TO 1                                                                000057
36    PRINT 101                                                              000058
      IPEN=3                                                                 000059
C                                                                            000060
C        CHANGE PENS AND PLOT R NOW ON THE SAME AXES.                        000061
      EX=0.                                                                  000062
      CALL NEWPEN(3)                                                         000063
      DO 201 I=1,IT                                                          000064
      X=XSC*EX                                                               000065
      Y=R(I)*YSC+YUP                                                         000066
      IF(Y.GT.9..OR.Y.LT.-9.) GO TO 201                                      000067
      CALL PLOT(X,Y,IPEN)                                                    000068
      EX=EX+1.                                                               000069
201   IPEN=2                                                                 000070
C                                                                            000071
C        DRAW THE X AXIS, MAKE TIC MARKS EVERY INCH AND LABEL THE AXIS.      000072
      CALL PLOT(0.,YUP,3)                                                    000073
      CALL PLOT(30.,YUP,2)                                                   000074
      CALL NEWPEN(1)                                                         000075
      WY=YUP-.1                                                              000076
      X=.5                                                                   000077
      DO 300 I=1,60                                                          000078
      CALL PLOT(X,YUP,3)                                                     000079
      CALL PLOT(X,WY,2)                                                      000080
300   X=X+.5                                                                 000081
      CALL SYMBOL(25.,0.,.14,8HOBSERVED,0.,8)                                000082
      CALL SYMBOL(25.,-.5,.14,5HMODEL,0.,5)                                  000083
      CALL PLOT(24.,0.,3)                                                    000084
      CALL PLOT(24.5,0.,2)                                                   000085
C                                                                            000086
C        LABEL THE PLOT TO IDENTIFY WHICH PEN IS PLOTTING WHICH DATA SET     000087
      CALL NEWPEN(3)                                                         000088
      CALL PLOT(24.,-.5,3)                                                   000089
      CALL PLOT(24.5,-.5,2)                                                  000090
99    CALL PLOT(0.,0.,999)                                                   000091
      STOP                                                                   000092
      END                                                                    000093
```

Values of h,Z,u,v at 48 time steps over one tidal cycle are plotted. The number of points, N, which can be plotted at one time is less than or equal to 50. For each point the grid, IC (1,N), and the x,y coordinates, IC (2,N), IC (3,N), are specified.

The finite difference formulation is identical to that used in Greenberg's Bay of Fundy model. Thus

$$\frac{1}{\Delta x}\left(d_{i-1,j}\,U_{i-1,j} - d_{i,j}\,U_{i,j}\right) \qquad T_1$$

$$+\ \frac{1}{\Delta y}\left(e_{i,j}\,V_{i,j} - e_{i,j-1}\,V_{i,j-1}\right) = 0 \qquad T_2$$

$$d_{i,j} = (h_{i,j} + Z_{i,j} + h_{i+1,j} + Z_{i+1,j})/2$$

$$e_{i,j} = (h_{i,j} + Z_{i,j} + h_{i,j+1} + Z_{i,j+1})/2$$

Calculated values for T_1 and T_2 at each of the 48 time steps are stored in the arrays ZMX (N, TIME STEP) and ZMY (N, TIME STEP) respectively.

As a check on the scales of the terms values of the four component terms of T_1, T_2 are printed out as well as ZMX, ZMY at each time step. Also neighbourhood values of U, V, h Z are printed.

Plots are labelled by the coordinates and grid of the point under consideration.

3.6.2 Conservation of Momentum

Program MOTION calculates and plots the terms in the two equations of motion

$$u\frac{\partial u}{\partial x} + v\frac{\partial u}{\partial y} - \gamma v + g\frac{\partial Z}{\partial x} + \frac{k\,u\,(u^2+v^2)^{1/2}}{h+Z} - \nabla^2 u = 0$$

$$u\frac{\partial v}{\partial x} + v\frac{\partial v}{\partial y} + \gamma u + g\frac{\partial Z}{\partial y} + \frac{k\,v\,(u^2+v^2)^{1/2}}{h+Z} - \nabla^2 v = 0$$

Again a specification of the number of points to be plotted, NPTS, and x,y coordinates of each point (IC(1, NPTS), IC(2, NPTS), IC(3, NPTS)) are required.

The finite difference formulation used by Greenberg is

$$U_{i,j}\,\frac{(U_{i+1,j} - U_{i-1,j})}{2\Delta x} \qquad + \qquad r_{i,j}\,\frac{(U_{i,j-1} - U_{i,j+1})}{2\Delta y} \qquad T_1$$

$$- \quad \gamma \, r_{i,j} \qquad T_2$$

$$+ \quad g \, \frac{(Z_{i+1,j} - Z_{i,j})}{\Delta x} \qquad T_3$$

$$+ \quad k \, U_{i,j} \, \frac{(U^2_{i,j} + r^2_{i,j})^{1/2}}{d_{i,j}} \qquad T_4$$

$$- \quad A_H \, (U_{i-1,j} + U_{i,j+1} + U_{i+1,j} + U_{i,j-1} - 4 \, U_{i,j}) \, / \, \Delta x^2 = 0 \qquad T_5$$

and

$$S_{i,j} \, \frac{(V_{i+1,j} - V_{i-1,j})}{2\Delta x} \quad + \quad V_{i,j} \, \frac{(V_{i,j-1} - V_{i,j+1})}{2\Delta y} \qquad T_1$$

$$+ \quad \gamma \, S_{i,j} \qquad T_2$$

$$+ \quad g \, \frac{(Z_{i,j} - Z_{i,j+1})}{\Delta y} \qquad T_3$$

$$+ \quad k \, v_{i,j} \, \frac{(S^2_{i,j} + V^2_{i,j})^{1/2}}{e_{i,j}} \qquad T_4$$

$$= \quad A_H \, (V_{i-1,j} + V_{i,j+1} + V_{i+1,j} + V_{i,j-1} - 4 \, V_{i,j}) / \Delta y^2 = 0 \qquad T_5$$

$$r_{i,j} = (V_{i,j-1} + V_{i+1,j-1} + V_{i,j} + V_{i+1,j}) / 4$$

$$s_{i,j} = (U_{i-1,j} + U_{i,j} + U_{i-1,j+1} + U_{i,j+1}) / 4$$

All these terms are plotted and a sixth plot of $T_2 + T_3 + T_4$ labelled SUM.

Calculation of u, v equations require separate runs. The section appropriate to the calculation of the terms is exchanged with those appropriate for the u, or v calculation.

Values at each of the 48 time steps are stored in array T (TERM NUMBER, POINT NUMBER, TIME STEP). Values in array T are listed for each point plotted.

Plots are labelled by the grid and coordinates of the point under consideration.

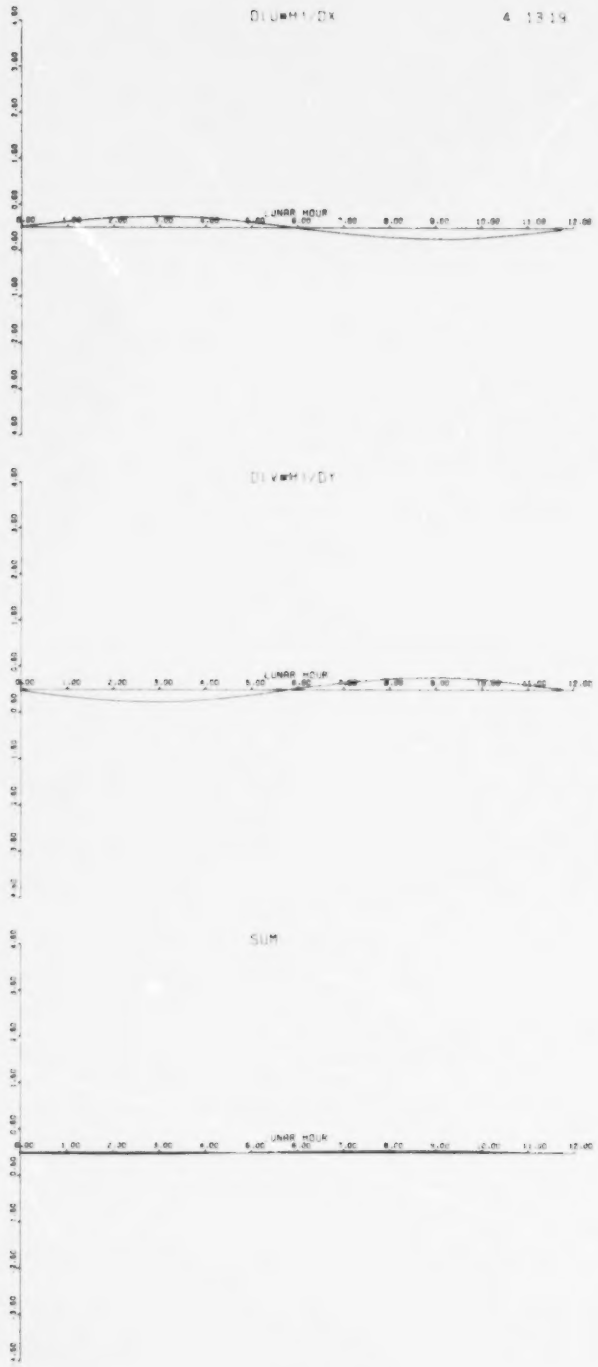

Figure 14

Sample plot of the 3 terms in equation of conservation of mass flux.

Table 12

The source listing of the program to calculate and plot the terms in the equation of conservation of mass flux.

```
      PROGRAM MFLUX(INPUT,OUTPUT,TAPE2,TAPE3,TAPE10)                          000001
      DIMENSION H1(29,65),H2(15,28),H3(25,17),H4(25,24),H5(22,33)             000002
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)             000003
      DIMENSION U1(29,65),U2(15,28),U3(25,17),U4(25,24),U5(22,33)             000004
      DIMENSION V1(29,65),V2(15,28),V3(25,17),V4(25,24),V5(22,33)             000005
      DIMENSION IC(3,50),BUFF(1),DX(5),ZMX(50,48),ZMY(50,48)                  000006
      DIMENSION H(29,65),Z(29,65),V(29,65),U(29,65)                           000007
      DATA DX/1.66,2.349,2.349,7.047,21.14/                                   000008
C                                                                             000009
C      READ THE GRID AND COORDINATES OF THE POINTS OF INTEREST                000010
      READ 100,N,FAC                                                          000011
100   FORMAT(I5,F6.2)                                                         000012
      READ 101,(IC(1,I),IC(2,I),IC(3,I),I=1,N)                                000013
101   FORMAT(3I5)                                                             000014
C                                                                             000015
C      READ THE DEPTH GRID                                                    000016
      READ(2) H1,H2,H3,H4,H5                                                  000017
C                                                                             000018
C      DO THE MASS FLUX CALCULATION FOR ALL POINTS IN EACH TIME STEP          000019
      DO 500 IT=1,48                                                          000020
      READ(3) Z1,Z2,Z3,Z4,Z5                                                  000021
      READ(3) U1,U2,U3,U4,U5                                                  000022
      READ(3) V1,V2,V3,V4,V5                                                  000023
      DO 501 IP=1,N                                                           000024
      JAY=IC(1,IP)                                                            000025
      GO TO (1,2,3,4,5)JAY                                                    000026
1     DO 10 I=1,29                                                            000027
      DO 10 J=1,65                                                            000028
      H(I,J)=H1(I,J)                                                          000029
      Z(I,J)=Z1(I,J)                                                          000030
      U(I,J)=U1(I,J)                                                          000031
10    V(I,J)=V1(I,J)                                                          000032
      GO TO 70                                                                000033
2     DO 20 I=1,15                                                            000034
      DO 20 J=1,28                                                            000035
      H(I,J)=H2(I,J)                                                          000036
      Z(I,J)=Z2(I,J)                                                          000037
      U(I,J)=U2(I,J)                                                          000038
20    V(I,J)=V2(I,J)                                                          000039
      GO TO 70                                                                000040
3     DO 30 I=1,25                                                            000041
      DO 30 J=1,17                                                            000042
      H(I,J)=H3(I,J)                                                          000043
      Z(I,J)=Z3(I,J)                                                          000044
      U(I,J)=U3(I,J)                                                          000045
30    V(I,J)=V3(I,J)                                                          000046
      GO TO 70                                                                000047
4     DO 40 I=1,25                                                            000048
      DO 40 J=1,24                                                            000049
      H(I,J)=H4(I,J)                                                          000050
      Z(I,J)=Z4(I,J)                                                          000051
      U(I,J)=U4(I,J)                                                          000052
40    V(I,J)=V4(I,J)                                                          000053
      GO TO 70                                                                000054
5     DO 50 I=1,22                                                            000055
      DO 50 J=1,33                                                            000056
      H(I,J)=H5(I,J)                                                          000057
      Z(I,J)=Z5(I,J)                                                          000058
      U(I,J)=U5(I,J)                                                          000059
50    V(I,J)=V5(I,J)                                                          000060
70    CONTINUE                                                                000061
      IX=IC(2,IP)                                                             000062
      IY=IC(3,IP)                                                             000063
      EHU1=U(IX-1,IY)*(H(IX-1,IY)+Z(IX-1,IY)+H(IX,IY)+Z(IX,IY))*.5            000064
      EHU2=U(IX,IY)*(H(IX,IY)+Z(IX,IY)+H(IX+1,IY)+Z(IX+1,IY))*.5              000065
      EHV1=V(IX,IY)*(H(IX,IY)+Z(IX,IY)+H(IX,IY+1)+Z(IX,IY+1))*.5              000066
      EHV2=V(IX,IY-1)*(H(IX,IY-1)+Z(IX,IY-1)+H(IX,IY)+Z(IX,IY))*.5            000067
      ZMX(IP,IT)=(EHU1-EHU2)/(100000.*DX(JAY))                                000068
      ZMY(IP,IT)=(EHV1-EHV2)/(100000.*DX(JAY))                                000069
      PRINT 801,EHU1,EHU2,EHV1,EHV2,ZMX(IP,IT),ZMY(IP,IT),IP,IT               000070
801   FORMAT(* *,6(5X,E10.4),2I5)                                             000071
      PRINT 802,U(IX-1,IY),U(IX,IY),V(IX-1,IY),V(IX,IY),Z(IX,IY-1),Z(IX-      000072
     +1,IY),Z(IX,IY),Z(IX+1,IY),Z(IX,IY+1),H(IX,IY-1),H(IX-1,IY),H(IX,IY      000073
     +),H(IX+1,IY),H(IX,IY+1)                                                 000074
802   FORMAT(* *,14E9.3)                                                      000075
501   CONTINUE                                                                000076
500   CONTINUE                                                                000077
C                                                                             000078
C      NOW PLOT THE RESULTS                                                   000079
C      INITIALISE THE PLOT ROUTINES                                           000080
      CALL PLOTS(BUFF,200,10)                                                 000081
      CALL FACTOR(FAC)                                                        000082
C                                                                             000083
C        SET THE SCALING FACTORS AND THE ORIGINS                              000084
      XSC=.25                                                                 000085
      YSC=1.                                                                  000086
      YUP3=4.5                                                                000087
      YUP2=YUP3+10.                                                           000088
      YUP1=YUP3+20.                                                           000089
      YL3=YUP3-4.5                                                            000090
      YL2=YUP2-4.5                                                            000091
      YL1=YUP1-4.5                                                            000092
C                                                                             000093
C      DO 3 PLOTS FOR EACH POINT OF INTEREST                                  000094
      DO 510 IP=1,N                                                           000095
      CALL PLOT(16.,-15.,-3)                                                  000096
      CALL PLOT(2.,2.,-3)                                                     000097
      EX=0.                                                                   000098
      IPEN=3                                                                  000099
      DO 502 IT=1,48                                                          000100
```

Table 12 (continued)

```
      X=EX*XSC                                                          000101
      Y=ZMX(IP,IT)*YSC+YUP1                                             000102
      CALL PLOT(X,Y,IPEN)                                               000103
      EX=EX+1.                                                          000104
  502 IPEN=2                                                            000105
      EX=0.                                                             000106
      IPEN=3                                                            000107
      DO 503 IT=1,48                                                    000108
      X=EX*XSC                                                          000109
      Y=ZMY(IP,IT)*YSC+YUP2                                             000110
      CALL PLOT(X,Y,IPEN)                                               000111
      EX=EX+1.                                                          000112
  503 IPEN=2                                                            000113
      EX=0.                                                             000114
      IPEN=3                                                            000115
      DO 504 IT=1,48                                                    000116
      X=EX*XSC                                                          000117
      Y=(ZMX(IP,IT)+ZMY(IP,IT))*YSC+YUP3                                000118
      CALL PLOT(X,Y,IPEN)                                               000119
      EX=EX+1.                                                          000120
  504 IPEN=2                                                            000121
C                                                                       000122
C      PLOT AND LABEL THE AXES                                          000123
      CALL AXIS(0.,YUP1,10HLUNAR HOUR,10,12.,0.,0.,1.)                  000124
      CALL AXIS(0.,YL1,1H ,1,9.,90.,-4.5,1.)                            000125
      CALL AXIS(0.,YUP2,10HLUNAR HOUR,10,12.,0.,0.,1.)                  000126
      CALL AXIS(0.,YL2,1H ,1,9.,90.,-4.5,1.)                            000127
      CALL AXIS(0.,YUP3,10HLUNAR HOUR,10,12.,0.,0.,1.)                  000128
      CALL AXIS(0.,YL3,1H ,1,9.,90.,-4.5,1.)                            000129
      PG=FLOAT(IC(1,IP))                                                000130
      PX=FLOAT(IC(2,IP))                                                000131
      PY=FLOAT(IC(3,IP))                                                000132
      CALL NUMBER(10.5,29.,.21,PG,0.,-1)                                000133
      CALL NUMBER(11.,29.,.21,PX,0.,-1)                                 000134
      CALL NUMBER(11.5,29.,.21,PY,0.,-1)                                000135
      CALL SYMBOL(5.,29.,.21,9HD(U*H)/DX,0.,9)                          000136
      CALL SYMBOL(5.,19.,.21,9HD(V*H)/DY,0.,9)                          000137
      CALL SYMBOL(5.,9.,.21,3HSUM,0.,3)                                 000138
  510 CONTINUE                                                          000139
      CALL PLOT(0.,0.,999)                                              000140
      STOP                                                              000141
      END                                                               000142
```

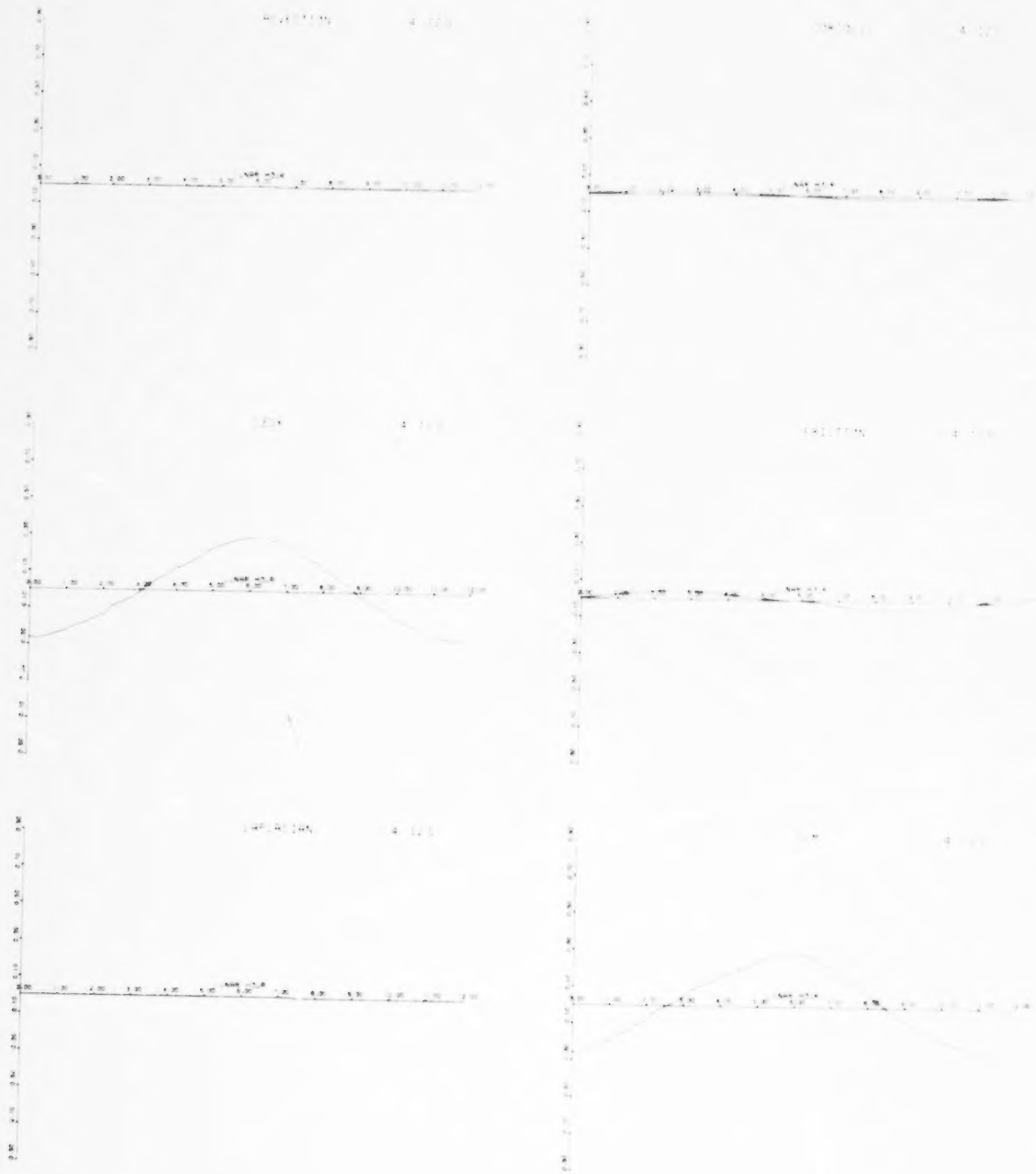

Figure 15

Sample plots of the terms in the equation of conservation of momentum.

Table 13

The source listing of the program to calculate and plot the terms in the equation of conservation of momentum.

```
      PROGRAM MOTION(INPUT,OUTPUT,TAPE2,TAPE3,TAPE10)                    000001
      DIMENSION H1(29,65),H2(15,28),H3(25,17),H4(25,24),H5(22,33)        000002
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)        000003
      DIMENSION U1(29,65),U2(15,28),U3(25,17),U4(25,24),U5(22,33)        000004
      DIMENSION V1(29,65),V2(15,28),V3(25,17),V4(25,24),V5(22,33)        000005
      DIMENSION BUFF(1),FC(5),GAMMA(5),DX(5),IC(3,10),LABEL(6)           000006
      DIMENSION T(6,10,48),AH(5)                                         000007
      DIMENSION Z(29,65),U(29,65),V(29,65),H(29,65)                      000008
      DATA LABEL/9HADVECTION,8HCORIOLIS,4HDZDY,8HFRICTION,9HLAPLACIAN,10 000009
     +HDZDY+CO+FR/                                                       000010
      DATA DX/1.66,2.349,2.349,7.047,21.14/                              000011
      DATA FC/.0021,.0021,.0021,.0021,.0024/                             000012
      DATA AH/1.E6,1.E6,1.E6,1.E6,1.E6/                                  000013
      DATA GAMMA/1.034E-4,1.039E-4,1.034E-4,1.028E-4,1.015E-4/           000014
C                                                                        000015
C      READ THE POINTS OF INTEREST                                       000016
      READ 100,NPTS,FAC                                                  000017
100   FORMAT(I5,F6.2)                                                    000018
      READ 101,(IC(1,I),IC(2,I),IC(3,I),I=1,NPTS)                        000019
101   FORMAT(3I5)                                                        000020
C                                                                        000021
C      READ THE DEPTH ARRAY                                              000022
      READ(2) H1,H2,H3,H4,H5                                             000023
      XSC=.25                                                            000024
      YSC=100.                                                           000025
      DO 200 IT=1,48                                                     000026
C                                                                        000027
C        READ THE Z,U,V DATA FOR EACH TIME STEP                          000028
      READ(3) U1,U2,U3,U4,U5                                             000029
      READ(3) V1,V2,V3,V4,V5                                             000030
      READ(3) Z1,Z2,Z3,Z4,Z5                                             000031
      DO 201 IP=1,NPTS                                                   000032
      JAY=IC(1,IP)                                                       000033
      GO TO (1,2,3,4,5)JAY                                               000034
C                                                                        000035
C        SET Z,H,U,V FOR THE APPROPRIATE GRID                            000036
1     DO 11 I=1,29                                                       000037
      DO 11 J=1,65                                                       000038
      H(I,J)=H1(I,J)                                                     000039
      Z(I,J)=Z1(I,J)                                                     000040
      U(I,J)=U1(I,J)                                                     000041
11    V(I,J)=V1(I,J)                                                     000042
      GO TO 20                                                           000043
2     DO 12 I=1,15                                                       000044
      DO 12 J=1,28                                                       000045
      H(I,J)=H2(I,J)                                                     000046
      Z(I,J)=Z2(I,J)                                                     000047
      U(I,J)=U2(I,J)                                                     000048
12    V(I,J)=V2(I,J)                                                     000049
      GO TO 20                                                           000050
3     DO 13 I=1,25                                                       000051
      DO 13 J=1,17                                                       000052
      H(I,J)=H3(I,J)                                                     000053
      Z(I,J)=Z3(I,J)                                                     000054
      U(I,J)=U3(I,J)                                                     000055
13    V(I,J)=V3(I,J)                                                     000056
      GO TO 20                                                           000057
4     DO 14 I=1,25                                                       000058
      DO 14 J=1,24                                                       000059
      H(I,J)=H4(I,J)                                                     000060
      Z(I,J)=Z4(I,J)                                                     000061
      U(I,J)=U4(I,J)                                                     000062
14    V(I,J)=V4(I,J)                                                     000063
      GO TO 20                                                           000064
5     DO 15 I=1,22                                                       000065
      DO 15 J=1,33                                                       000066
      H(I,J)=H5(I,J)                                                     000067
      Z(I,J)=Z5(I,J)                                                     000068
      U(I,J)=U5(I,J)                                                     000069
15    V(I,J)=V5(I,J)                                                     000070
20    CONTINUE                                                           000071
      IX=IC(2,IP)                                                        000072
      IY=IC(3,IP)                                                        000073
      DO 202 NT=1,5                                                      000074
      GO TO (31,32,33,34,35)NT                                           000075
C                                                                        000076
C        CALCULATE THE TERMS IN THE EQUATION OF MOTION                   000077
C        THE V EQUATION                                                  000078
31    YOU=(U(IX-1,IY)+U(IX,IY)+U(IX-1,IY+1)+U(IX,IY+1))/4.               000079
      TA=YOU*(V(IX+1,IY)-V(IX-1,IY))/(200000.*DX(JAY))                   000080
      TB=V(IX,IY)*(V(IX,IY-1)-V(IX,IY+1))/(200000.*DX(JAY))              000081
      T(1,IP,IT)=TA+TB                                                   000082
      GO TO 40                                                           000083
32    YOU=(U(IX-1,IY)+U(IX,IY)+U(IX-1,IY+1)+U(IX,IY+1))/4.               000084
      T(2,IP,IT)=GAMMA(JAY)*YOU                                          000085
      T(6,IP,IT)=T(6,IP,IT)+T(2,IP,IT)                                   000086
      GO TO 40                                                           000087
33    DZ=.125*(4.*Z(I,J)+Z(I+1,J)+Z(I-1,J)+Z(I,J+1)+Z(I,J-1))-.125*(4.*Z 000088
     +(I,J+1)+Z(I,J+1)+Z(I,J+2)+Z(I+1,J+1)+Z(I-1,J+1))                   000089
      T(3,IP,IT)=980.*DZ/(100000.*DX(JAY))                               000090
      T(6,IP,IT)=T(6,IP,IT)+T(3,IP,IT)                                  000091
      GO TO 40                                                           000092
34    YOU=(U(IX-1,IY)+U(IX,IY)+U(IX-1,IY+1)+U(IX,IY+1))/4.               000093
      HCH=(H(IX,IY)+Z(IX,IY)+H(IX,IY+1)+Z(IX,IY+1))/2.                   000094
      T(4,IP,IT)=FC(JAY)*V(IX,IY)*SQRT(YOU**2+V(IX,IY)**2)/HCH           000095
      T(6,IP,IT)=T(6,IP,IT)+T(4,IP,IT)                                  000096
      GO TO 40                                                           000097
35    VEE=V(IX-1,IY)+V(IX,IY-1)+V(IX+1,IY)+V(IX,IY+1)                    000098
      T(5,IP,IT)=-AH(JAY)*(VEE-4.*V(IX,IY))/(100000.*DX(JAY))**2         000099
40    CONTINUE                                                           000100
202   CONTINUE                                                           000101
201   CONTINUE                                                           000102
200   CONTINUE                                                           000103
```

Table 13 (continued)

```
C                                                                       000104
C          NOW PLOT THE RESULTS                                         000105
      CALL PLOTS(BUFF,200,10)                                           000106
      CALL PLOT(0.,-30.,-3)                                             000107
      CALL PLOT(3.,3.,-3)                                               000108
      CALL FACTOR(FAC)                                                  000109
      DO 300 IP=1,NPTS                                                  000110
      XDUM=25./FAC                                                      000111
      XDUM2=3./FAC                                                      000112
      CALL PLOT(XDUM,-30.,-3)                                           000113
      CALL PLOT(XDUM2,XDUM2,-3)                                         000114
      DO 301 NT=1,6                                                     000115
      EX=0.                                                             000116
      IPEN=3                                                            000117
C                                                                       000118
C          SET THE ORIGINS                                              000119
      GO TO (41,42,43,44,45,46)NT                                       000120
41    XUP=7.                                                            000121
      YUP=0.                                                            000122
      GO TO 50                                                          000123
42    XUP=7.                                                            000124
      YUP=15.                                                           000125
      GO TO 50                                                          000126
43    XUP=21.                                                           000127
      YUP=0.                                                            000128
      GO TO 50                                                          000129
44    XUP=21.                                                           000130
      YUP=15.                                                           000131
      GO TO 50                                                          000132
45    XUP=35.                                                           000133
      YUP=0.                                                            000134
      GO TO 50                                                          000135
46    XUP=35.                                                           000136
      YUP=15.                                                           000137
50    CONTINUE                                                          000138
C                                                                       000139
C          LABEL THE PLOTS                                              000140
      XL=XUP+6.                                                         000141
      XL1=XUP-6.0                                                       000142
      YL=YUP+6.                                                         000143
      YL3=YL-5.                                                         000144
      YL1=YL+4.                                                         000145
      YL2=YL+4.5                                                        000146
      CALL AXIS(XUP,YUP,10HLUNAR HOUR,10,12.,90.,0.,1.)                 000147
      CALL AXIS(XL,YUP,1H ,1,12.,180.,-6.,1.)                           000148
      CALL SYMBOL(XL1,YL3,.21,10HV EQUATION,90.,10)                     000149
      CALL SYMBOL(XL1,YL,.21,LABEL(NT),90.,10)                          000150
      YL3=YL+5.                                                         000151
      PG=FLOAT(IC(1,IP))                                                000152
      PX=FLOAT(IC(2,IP))                                                000153
      PY=FLOAT(IC(3,IP))                                                000154
      CALL NUMBER(XL1,YL1,.21,PG,90.,-1)                                000155
      CALL NUMBER(XL1,YL2,.21,PX,90.,-1)                                000156
      CALL NUMBER(XL1,YL3,.21,PY,90.,-1)                                000157
C                                                                       000158
C          PLOT THE POINTS                                              000159
      DO 302 IT=1,48                                                    000160
      X=EX*XSC+YUP                                                      000161
      Y=T(NT,IP,IT)*YSC+XUP                                             000162
      CALL PLOT(Y,X,IPEN)                                               000163
      EX=EX+1.                                                          000164
302   IPEN=2                                                            000165
301   CONTINUE                                                          000166
300   CONTINUE                                                          000167
      CALL PLOT(0.,0.,999)                                              000168
C                                                                       000169
C          PRINT THE DATA WHICH WAS PLOTTED                             000170
      DO 701 IP=1,NPTS                                                  000171
      PRINT 700,IC(1,IP),IC(2,IP),IC(3,IP)                              000172
700   FORMAT(* COORDINATES OF THE DATA PLOTTED*,3I5)                    000173
      PRINT 703                                                         000174
703   FORMAT(3X,*ADVECTION*,6X,*CORIOLIS*,9X,*DZDY*,9X,*FRICTION*,7X,*LA 000175
     +PLACE AN*,9X,*SUM*)                                               000176
      DO 701 IT=1,48                                                    000177
701   PRINT 702,(T(NT,IP,IT),NT=1,6)                                    000178
702   FORMAT(* *,6(5X,E10.4))                                           000179
      STOP                                                              000180
      END                                                               000181
```

Table 13 (continued)

```
      DATA LABEL/9HADVECTION,8HCORIOLIS,4HDZDX,8HFRICTION,9HLAPLACIAN,10      000009
     +HDZDX+CO+FR/                                                            000010


C                                                                             000076
C        CALCULATE THE TERMS IN THE EQUATION OF MOTION                        000077
C        THE U EQUATION                                                       000078
 37   VEE=(V(IX,IY-1)+V(IX+1,IY-1)+V(IX,IY)+V(IX+1,IY))/4.                   000079
      TA=U(IX,IY)*(U(IX+1,IY)-U(IX-1,IY))/(200000.*DX(JAY))                   000080
      TB=VEE*(U(IX,IY)-U(IX,IY+1))/(200000.*DX(JAY))                          000081
      T(1,IP,IT)=TA+TB                                                        000082
      GO TO 40                                                                000083
 38   VEE=(V(IX,IY-1)+V(IX+1,IY-1)+V(IX,IY)+V(IX+1,IY))/4.                   000084
      T(2,IP,IT)=-GAMMA(JAY)*VEE                                              000085
      T(6,IP,IT)=T(6,IP,IT)+T(2,IP,IT)                                        000086
      GO TO 40                                                                000087

 **********  DELETE LINES 88 , 89  **********

 33   T(3,IP,IT)=980.*(Z(IX+1,IY)-Z(IX,IY))/(100000.*DX(JAY))                 000090
      T(6,IP,IT)=T(6,IP,IT)+T(3,IP,IT)                                        000091
      GO TO 40                                                                000092
 34   VEE=(V(IX,IY-1)+V(IX+1,IY-1)+V(IX,IY)+V(IX+1,IY))/4.                   000093
      HCH=(H(IX,IY)+Z(IX,IY)+H(IX+1,IY)+Z(IX+1,IY))/2.                        000094
      T(4,IP,IT)=FC(JAY)*U(IX,IY)*SQRT(U(IX,IY)**2+VEE**2)/HCH                000095
      T(6,IP,IT)=T(6,IP,IT)+T(4,IP,IT)                                        000096
      GO TO 40                                                                000097
 35   YOU=U(IX-1,IY)+U(IX,IY+1)+U(IX+1,IY)+U(IX,IY-1)                         000098
      T(5,IP,IT)=-AH(JAY)*(YOU-4.*U(IX,IY))/(100000.*DX(JAY))**2              000099
 40   CONTINUE                                                                000100


      CALL SYMBOL(XL1,YL3,.21,10HU EQUATION,90.,10)                           000149


 701  FORMAT(3X,*ADVECTION*,6X,*CORIOLIS*,9X,*DZDX*,9X,*FRICTION*,7X,*LA      000175
```

APPENDIX A: Source Listing and Sample Run of Program BFCNRG

```
      PROGRAM BFCNRG(INPUT,OUTPUT,TAPE1,TAPE10,TAPE2,TAPE3)                    000001
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)              000002
      DIMENSION BUFF(1),DIV(3)                                                 000003
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                          000004
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                                  000005
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                                000006
      DATA DIV/1.,1.,1./                                                       000007
      REWIND 2                                                                 000008
      REWIND 3                                                                 000009
      REWIND 1                                                                 000010
      ND=1                                                                     000011
C                                                                              000012
C        READ BAY OF FUNDY GRID COORDINATES FROM TAPE 1                        000013
      DO 100 I=1,5                                                             000014
      KJ=6-I                                                                   000015
      READ(1,500) IGRDNO,NPTS(KJ)                                              000016
500   FORMAT(5X,I2,I3)                                                         000017
501   FORMAT(9(I1,I2,1X,I2))                                                   000018
      J=NPTS(KJ)                                                               000019
100   READ(1,501) ((IGRD(II,JJ,KJ),II=1,3),JJ=1,J)                             000020
C                                                                              000021
C        READ BASESC, IWNTGRD, FAC FROM INPUT                                  000022
      PRINT 876                                                                000023
876   FORMAT(* *,*INPUT:BASESC,IWNTGRD,FAC*)                                   000024
      READ 502,BASESC,(IWNTGRD(I),I=1,5),FAC                                   000025
502   FORMAT(F4.2,5I1,F4.2)                                                    000026
      PRINT 800,BASESC,(IWNTGRD(I),I=1,5),FAC                                  000027
800   FORMAT(* *,*BASESC=*,F6.2,* IWNTGRD=*,5I2,* FACTOR=*,F6.2)               000028
      PRINT 181                                                                000029
181   FORMAT(* *,*INPUT: CONTOUR(5F5.0)*)                                      000030
182   FORMAT(5F5.0)                                                            000031
801   FORMAT(* *,*VALUES CONTOURED =*,6F7.1)                                   000032
C                                                                              000033
C        INITIALIZE PLOT ROUTINE AND SET ORIGIN                                000034
      CALL PLOTS(BUFF,200,10)                                                  000035
      CALL FACTOR(FAC)                                                         000036
C                                                                              000037
C       READ DATA, NVC, CONTOURS, LABEL                                        000038
      READ 822,ALAB                                                            000039
822   FORMAT(A10)                                                              000040
      DO 779 NDATA=1,3                                                         000041
      READ(3) Z1,Z2,Z3,Z4,Z5                                                   000042
      READ 183,NVC                                                             000043
183   FORMAT(I5)                                                               000044
      READ 182,(CONTOUR(I),I=1,NVC)                                            000045
      PRINT 802,NDATA                                                          000046
802   FORMAT(* *,*PLOT *,I5)                                                   000047
      PRINT 801,(CONTOUR(I),I=1,NVC)                                           000048
      FRA=DIV(NDATA)                                                           000049
C                                                                              000050
C       MOVE THE ORIGIN OVER AND DOWN TO THE BOTTOM OF THE PAGE                000051
      SCA=40.*FAC                                                              000052
      SC=-30.*FAC                                                              000053
      CALL PLOT(SCA,SC,-3)                                                     000054
      CALL PLOT(3.,3.,-3)                                                      000055
      XUP=0.                                                                   000056
      YUP=0.                                                                   000057
C                                                                              000058
C        CHECK WHICH GRIDS ARE TO BE PLOTTED AND PROCEED ACCORDINGLY           000059
      DO 101 I=1,5                                                             000060
      IF(IWNTGRD(I).EQ.0) GO TO 10                                             000061
      GO TO (1,2,3,4,5) IWNTGRD(I)                                             000062
C                                                                              000063
C        GRID 5 (GULF OF MAINE)                                                000064
5     DO 51 II=1,22                                                            000065
      DO 51 JJ=1,33                                                            000066
51    Z(II,JJ)=(Z5(II,JJ))/FRA                                                 000067
C                                                                              000068
C       MAKE INTERPOLATIONS. ALL VALUES ARE SCALED BY FRA.                     000069
      DO 53 II=12,18                                                           000070
53    Z(II,1)=(2.*Z5(II,2)-Z5(II,3))/FRA                                       000071
      DO 54 II=9,15                                                            000072
54    Z(II,33)=(2.*Z5(II,32)-Z5(II,31))/FRA                                    000073
      DO 55 II=4,12                                                            000074
55    Z(18,II)=(2.*Z5(17,II)-Z5(16,II))/FRA                                    000075
      Z(19,2)=(2.*Z5(18,2)-Z5(17,2))/FRA                                       000076
      Z(19,3)=(2.*Z5(18,3)-Z5(17,3))/FRA                                       000077
      DO 56 II=13,15                                                           000078
56    Z(19,II)=(2.*Z5(18,II)-Z5(17,II))/FRA                                    000079
      DO 57 II=16,17                                                           000080
57    Z(20,II)=(2.*Z5(19,II)-Z5(18,II))/FRA                                    000081
      NM=21                                                                    000082
      M=1                                                                      000083
      DO 58 II=18,29                                                           000084
      Z(NM,II)=(2.*Z5(NM-1,II)-Z5(NM-2,II))/FRA                                000085
      M=M+1                                                                    000086
      IF(M.LE.4) GO TO 58                                                      000087
      M=1                                                                      000088
      NM=NM-1                                                                  000089
58    CONTINUE                                                                 000090
      Z(18,30)=(2.*Z5(17,30)-Z5(16,30))/FRA                                    000091
      Z(17,31)=(2.*Z5(16,31)-Z5(15,31))/FRA                                    000092
      Z(16,32)=(2.*Z5(15,32)-Z5(14,32))/FRA                                    000093
C                                                                              000094
C       DRAW THE GRID OUTLINE                                                  000095
      CALL NEWPEN(1)                                                           000096
      CALL GRID5(I,BASESC)                                                     000097
C                                                                              000098
C        CONTOUR VALUES IN THIS GRID                                           000099
      CALL NEWPEN(2)                                                           000100
      IF(NDATA.NE.1) GO TO 52                                                  000101
      CALL CELLIJ(I,NVC)                                                       000102
      GO TO 101                                                                000103
52    CALL CELL(I,NVC)                                                         000104
      GO TO 101                                                                000105
C                                                                              000106
C        GRID 4 (BAY OF FUNDY)                                                 000107
4     DO 41 II=1,25                                                            000108
```

```
      DO 41 JJ=1,24                                                     000109
41    Z(II,JJ)=(Z4(II,JJ))/FRA                                          000110
C                                                                       000111
C      MAKE INTERPOLATIONS                                              000112
      Z(7,24)=(2.*Z4(7,23)-Z4(7,22))/FRA                                000113
      M=4                                                               000114
      DO 45 II=8,23,3                                                   000115
      Z(II,24)=(Z4(II,23)+Z5(M,9))/(2.*FRA)                             000116
45    M=M+1                                                             000117
      DO 46 II=8,20,3                                                   000118
      Z(II+1,24)=(Z(II,24)+(Z(II+3,24)-Z(II,24))/3.)                    000119
46    Z(II+2,24)=(Z(II,24)+(Z(II+3,24)-Z(II,24))/1.5)                   000120
      Z(24,24)=(2.*Z(23,24)-Z(22,24))                                   000121
      Z(7,25)=Z(7,24)+(Z(7,24)-Z(7,23))                                 000122
      Z(25,24)=2.*Z(24,24)-Z(23,24)                                     000123
      M=4                                                               000124
      DO 43 II=8,23,3                                                   000125
      Z(II,25)=Z5(M,9)/FRA                                              000126
      Z(II+1,25)=(Z5(M,9)+(Z5(M+1,9)-Z5(M,9))/3.)/FRA                   000127
      Z(II+2,25)=(Z5(M,9)+(Z5(M+1,9)-Z5(M,9))/1.5)/FRA                  000128
43    M=M+1                                                             000129
      CALL NEWPEN(1)                                                    000130
      Z(25,25)=(2.*Z(24,25)-Z(23,25))                                   000131
C                                                                       000132
C      DRAW THE GRID OUTLINE                                            000133
      CALL GRID4(I,BASESC)                                              000134
C                                                                       000135
C      CONTOUR VALUES IN THIS GRID                                      000136
      CALL NEWPEN(2)                                                    000137
      IF(I.NE.1) GO TO 42                                               000138
      IF(NDATA.NE.1) GO TO 42                                           000139
      CALL CELLIJ(I,NVC)                                                000140
      GO TO 101                                                         000141
42    CALL CELL(I,NVC)                                                  000142
      GO TO 101                                                         000143
C                                                                       000144
C        GRID 3 (CHIGNECTO HEAD)                                        000145
3     DO 31 II=1,25                                                     000146
      DO 31 JJ=1,17                                                     000147
31    Z(II,JJ)=Z3(II,JJ)/FRA                                            000148
C                                                                       000149
C      MAKE INTERPOLATIONS                                              000150
      DO 33 II=3,8                                                      000151
      M=II+5                                                            000152
33    Z(II,1)=Z2(M,26)/FRA                                              000153
      M=9                                                               000154
      DO 35 II=3,21,3                                                   000155
      Z(II,17)=(Z3(II,16)+Z4(M,2))/(2.*FRA)                             000156
35    M=M+1                                                             000157
      DO 36 II=3,18,3                                                   000158
      Z(II+1,17)=(Z(II,17)+(Z(II+3,17)-Z(II,17))/3.)                    000159
36    Z(II+2,17)=(Z(II,17)+(Z(II+3,17)-Z(II,17))/1.5)                   000160
      Z(2,17)=(2.*Z(3,17)-Z(4,17))                                      000161
      Z(22,17)=(2.*Z(21,17)-Z(20,17))                                   000162
      M=9                                                               000163
      DO 34 II=3,18,3                                                   000164
      Z(II,18)=Z4(M,2)/FRA                                              000165
      Z(II+1,18)=(Z4(M,2)+(Z4(M+1,2)-Z4(M,2))/3.)/FRA                   000166
      Z(II+2,18)=(Z4(M,2)+(Z4(M+1,2)-Z4(M,2))/1.5)/FRA                  000167
34    M=M+1                                                             000168
      Z(21,18)=Z4(15,2)/FRA                                             000169
      Z(2,18)=2.*Z(3,18)-Z(4,18)                                        000170
      Z(22,18)=2.*Z(21,18)-Z(20,18)                                     000171
      M=63                                                              000172
      DO 37 II=19,24                                                    000173
      Z(II,2)=(Z1(II-1,M)+Z1(II,M-1))/(2.*FRA)                          000174
37    M=M-1                                                             000175
      Z(18,2)=Z1(18,63)/FRA                                             000176
C                                                                       000177
C      DRAW THE GRID OUTLINE                                            000178
      CALL NEWPEN(1)                                                    000179
      CALL GRID3(I,BASESC)                                              000180
C                                                                       000181
C      CONTOUR VALUES IN THIS GRID                                      000182
      CALL NEWPEN(2)                                                    000183
      IF(I.NE.1) GO TO 32                                               000184
      IF(NDATA.NE.1) GO TO 32                                           000185
      CALL CELLIJ(I,NVC)                                                000186
      GO TO 101                                                         000187
32    CALL CELL(I,NVC)                                                  000188
      GO TO 101                                                         000189
C                                                                       000190
C        GRID 2 (CHIGNECTO BAY)                                         000191
2     DO 21 II=1,15                                                     000192
      DO 21 JJ=1,28                                                     000193
21    Z(II,JJ)=Z2(II,JJ)/FRA                                            000194
C                                                                       000195
C      NO INTERPOLATIONS NEEDED. DRAW THE GRID OUTLINE.                 000196
      CALL NEWPEN(1)                                                    000197
      CALL GRID2(I,BASESC)                                              000198
C                                                                       000199
C      CONTOUR VALUES IN THIS GRID                                      000200
      CALL NEWPEN(2)                                                    000201
      IF(I.NE.1) GO TO 22                                               000202
      IF(NDATA.NE.1) GO TO 22                                           000203
      CALL CELLIJ(I,NVC)                                                000204
      GO TO 101                                                         000205
22    CALL CELL(I,NVC)                                                  000206
      GO TO 101                                                         000207
C                                                                       000208
C        GRID 1 (MINAS BASIN)                                           000209
1     DO 11 II=1,29                                                     000210
      DO 11 JJ=1,65                                                     000211
11    Z(II,JJ)=Z1(II,JJ)                                                000212
C                                                                       000213
C      DRAW THE GRID OUTLINE                                            000214
      CALL NEWPEN(1)                                                    000215
      CALL GRID1(I,BASESC)                                              000216
```

```
C
C      CONTOUR VALUES IN THIS GRID                                      000217
       CALL NEWPEN(2)                                                   000218
       IF(I.NE.1) GO TO 12                                              000219
       IF(NDATA.NE.1) GO TO 12                                          000220
       CALL CELLIJ(I,NVC)                                               000221
       GO TO 101                                                        000222
12     CALL CELL(I,NVC)                                                 000223
101    CONTINUE                                                         000224
10     CONTINUE                                                         000225
C                                                                       000226
C         GO BACK TO THE ORIGIN OF THE PLOT AND LABEL                   000227
       CALL PLOT(XUP,YUP,-3)                                            000228
       IF(IWNTGRD(1).EQ.3) GO TO 204                                    000229
       HX=27.                                                           000230
       HY=11.5                                                          000231
       GO TO 205                                                        000232
204    HX=10.                                                           000233
       HY=4.                                                            000234
       HXK=HX+6.                                                        000235
       HYK=HY+3.25                                                      000236
       HXM=HX+11.5                                                      000237
       HYM=HY+18.                                                       000238
       HXN=HX+11.                                                       000239
       HYN=HX+3.                                                        000240
       GO TO 2011                                                       000241
205    CONTINUE                                                         000242
       HXN=HX+7.75                                                      000243
       HYN=HY+4.                                                        000244
       HXY=HX-2.75                                                      000245
       HXK=HX+5.                                                        000246
       HYK=HY+2.25                                                      000247
       HXSJ=HX+2.                                                       000248
       HYSJ=HY+6.5                                                      000249
       HXSA=HX-2.                                                       000250
       HYSA=HY+8.5                                                      000251
       HXB=HX-23.                                                       000252
       HYB=HY+4.                                                        000253
       HXM=HX+7.75                                                      000254
       HYM=HY+6.75                                                      000255
       CALL SYMBOL(HXY,HY,.14,8HYARMOUTH,0.,8)                          000256
       CALL SYMBOL(HXSA,HYSA,.14,10HST.ANDREWS,0.,10)                   000257
       CALL SYMBOL(HXSJ,HYSJ,.14,8HST. JOHN,0.,8)                       000258
       CALL SYMBOL(HXB,HYB,.14,6HBOSTON,0.,6)                           000259
2011   CALL SYMBOL(HXM,HYM,.14,7HMONCTON,0.,7)                          000260
       CALL SYMBOL(HXK,HYK,.14,9HKENTVILLE,0.,9)                        000261
       HXN1=HXN+.689                                                    000262
       HYN1=HYN+1.142                                                   000263
       HYN1=HYN1-.055                                                   000264
       HXN2=HXN1-.118                                                   000265
       HYN2=HYN1-.118                                                   000266
       CALL PLOT(HXN,HYM,3)                                             000267
       CALL PLOT(HXN1,HYN1,2)                                           000268
       CALL PLOT(HXN2,HYN3,2)                                           000269
       CALL PLOT(HXN1,HYN2,2)                                           000270
       CALL PLOT(HXN1,HYN1,2)                                           000271
       CALL SYMBOL(HXN1,HYN1,.14,1HN,-31.,1)                            000272
       HY1=HY+1.                                                        000273
       HX1=HX+2.8                                                       000274
       HX2=HX+5.6                                                       000275
       HX3=HX+8.4                                                       000276
       HY2=HY-1.                                                        000277
       GO TO (200,201,202) ND                                           000278
200    CALL SYMBOL(HX,HY,.28,10HMEAN POTEN,0.,10)                       000279
       CALL SYMBOL(HX1,HY,.28,10HTIAL ENERG,0.,10)                      000280
       CALL SYMBOL(HX2,HY,.28,9HY / CM**2,0.,9)                         000281
       CALL SYMBOL(HX,HY2,.28,10HIN UNITS O,0.,10)                      000282
       CALL SYMBOL(HX1,HY2,.28,10HF 10**-2 J,0.,10)                     000283
       CALL SYMBOL(HX2,HY2,.28,5HOULES,0.,5)                            000284
       GO TO 203                                                        000285
201    CALL SYMBOL(HX,HY,.28,10HMEAN KINET,0.,10)                       000286
       CALL SYMBOL(HX1,HY,.28,10HIC ENERGY ,0.,10)                      000287
       CALL SYMBOL(HX2,HY,.28,10H / CM**2  ,0.,10)                      000288
       CALL SYMBOL(HX,HY2,.28,10HIN UNITS O,0.,10)                      000289
       CALL SYMBOL(HX1,HY2,.28,10HF 10**-2 J,0.,10)                     000290
       CALL SYMBOL(HX2,HY2,.28,5HOULES,0.,5)                            000291
       GO TO 203                                                        000292
202    CALL SYMBOL(HX,HY,.28,10HMEAN FRICT,0.,10)                       000293
       CALL SYMBOL(HX1,HY,.28,10HIONAL DISS,0.,10)                      000294
       CALL SYMBOL(HX2,HY,.28,10HIPATION / ,0.,10)                      000295
       CALL SYMBOL(HX3,HY,.28,9HCM**2/SEC,0.,9)                         000296
       CALL SYMBOL(HX,HY2,.28,10HIN UNITS O,0.,10)                      000297
       CALL SYMBOL(HX1,HY2,.28,10HF 10**-5 J,0.,10)                     000298
       CALL SYMBOL(HX2,HY2,.28,5HOULES,0.,5)                            000299
203    CONTINUE                                                         000300
       ND=ND+1                                                          000301
       CALL SYMBOL(HX,HY1,.28,ALAB,0.,10)                               000302
779    CONTINUE                                                         000303
       PRINT 803,ALAB                                                   000304
803    FORMAT(' *,A10)                                                  000305
       CALL PLOT(0.,0.,999)                                             000306
       STOP                                                             000307
       END                                                              000308
C                                                                       000309
C***********************************************************************000310
C                                                                       000311
       SUBROUTINE GRID5(I,BASESC)                                       000312
       COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                  000313
       COMMON E(29,65),IB(4),CONTOUR(30),SCALE                          000314
       COMMON IST(5),IWD(5),IEDGE(29,65,5),NDATA                        000315
C                                                                       000316
C         MOVE PEN TO THE ORIGIN OF GRID 5                              000317
       CALL PLOT(33.,22.,-3)                                            000318
       SCALE=BASESC                                                     000319
       CALL GRDPLOT(I)                                                  000320
C                                                                       000321
C         SET XUP, YUP TO MAINTAIN ORIGIN OF THE PLOT                   000322
       XUP=-33.                                                         000323
                                                                        000324
```

```
      YUP=-22.                                                          000325
      RETURN                                                            000326
      END                                                               000327
C                                                                       000328
C*****************************************************************    000329
C                                                                       000330
      SUBROUTINE GRID4(I,BASESC)                                        000331
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000332
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000333
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                         000334
C                                                                       000335
C        CHECK IF GRID 4 IS THE FIRST TO BE PLOTTED                     000336
C        MOVE THE ORIGIN FROM THE PREVIOUS POSITION TO THE              000337
C          ORIGIN FOR GRID 4.                                           000338
      IF(I.EQ.1) GO TO 41                                               000339
      SCALE=BASESC/3.                                                   000340
      X=-9.*BASESC+24.*SCALE                                            000341
      Y=-4.*BASESC+7.*SCALE                                             000342
      GO TO 42                                                          000343
C                                                                       000344
C        SET PEN TO ORIGIN OF GRID 4                                    000345
41    X=24.                                                             000346
      Y=25.                                                             000347
      SCALE=BASESC                                                      000348
42    CALL PLOT(X,Y,-3)                                                 000349
      CALL GRDPLOT(I)                                                   000350
C                                                                       000351
C        SET XUP,YUP TO MAINTAIN ORIGIN OF PLOT                         000352
      XUP=XUP-X                                                         000353
      YUP=YUP-Y                                                         000354
      RETURN                                                            000355
      END                                                               000356
C                                                                       000357
C*****************************************************************    000358
C                                                                       000359
      SUBROUTINE GRID3(I,BASESC)                                        000360
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000361
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000362
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                         000363
C                                                                       000364
C        CHECK IF GRID 3 IS THE FIRST TO BE PLOTTED                     000365
      IF(I.EQ.1) GO TO 31                                               000366
      SCALE=BASESC/9.                                                   000367
      IF(IWNTGRD(1).EQ.4) SCALE=SCALE*3.                                000368
C                                                                       000369
CC       SET PEN TO ORIGIN OF GRID 3                                    000370
      X= 2.*SCALE*3.+17.*SCALE                                          000371
      Y= 9.*SCALE*3.+2.*SCALE                                           000372
      GO TO 34                                                          000373
C                                                                       000374
C        IF GRID 3 IS THE FIRST WE MUST CHECK HOW MANY GRIDS ARE TO     000375
C         FOLLOW IN ORDER TO SCALE THE PLOTS CORRECTLY TO FIT ON ONE    000376
C         PLOT                                                          000377
31    IF(IWNTGRD(I+1).EQ.2.AND.IWNTGRD(I+2).EQ.1) GO TO 33              000378
      IF(IWNTGRD(I+1).EQ.1) GO TO 33                                    000379
C                                                                       000380
C        ADJUST SCALE SO THE WHOLE PLOT FITS                            000381
      SCALE=BASESC*.8                                                   000382
      GO TO 35                                                          000383
33    SCALE=BASESC*.4                                                   000384
35    X=17.                                                             000385
      Y=20.                                                             000386
34    CALL PLOT(X,Y,-3)                                                 000387
      CALL GRDPLOT(I)                                                   000388
C                                                                       000389
C        SET XUP,YUP TO MAINTAIN ORIGIN OF THE PLOT                     000390
      XUP=XUP-X                                                         000391
      YUP=YUP-Y                                                         000392
      RETURN                                                            000393
      END                                                               000394
C                                                                       000395
C*****************************************************************    000396
C                                                                       000397
      SUBROUTINE GRID2(I,BASESC)                                        000398
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000399
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000400
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                         000401
C                                                                       000402
C        CHECK IF GRID 2 IS THE FIRST TO BE PLOTTED                     000403
      IF(I.EQ.1) GO TO 21                                               000404
C                                                                       000405
C        SET THE SCALES CORRECTLY ON THE PLOTS                          000406
      GO TO (22,23,24) (IWNTGRD(1)-2)                                   000407
24    SCALE=BASESC/9.                                                   000408
      GO TO 26                                                          000409
23    SCALE=BASESC/3.                                                   000410
      GO TO 26                                                          000411
C                                                                       000412
C        CHECK IF GRID 1 IS TO BE PLOTTED                               000413
22    IF(IWNTGRD(I+1).EQ.1) GO TO 25                                    000414
      SCALE=BASESC*.8                                                   000415
      GO TO 26                                                          000416
25    SCALE=BASESC*.4                                                   000417
26    X=(-2.+27.)*SCALE                                                 000418
      Y=(-3.+8.)*SCALE                                                  000419
      GO TO 27                                                          000420
21    X=27.                                                             000421
      Y=15.                                                             000422
      SCALE=BASESC                                                      000423
27    CALL PLOT(X,Y,-3)                                                 000424
      CALL GRDPLOT(I)                                                   000425
C                                                                       000426
C        SET XUP,YUP TO MAINTAIN ORIGIN OF THE PLOT                     000427
      XUP=XUP-X                                                         000428
      YUP=YUP-Y                                                         000429
      RETURN                                                            000430
      END                                                               000431
C                                                                       000432
```

```
C*****************************************************************      000433
C                                                                      000434
      SUBROUTINE GRID1(I,BASESC)                                       000435
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                  000436
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                          000437
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                        000438
      ROOT2=SQRT(2.)                                                   000439
C                                                                      000440
C        CHECK IF GRID 1 IS THE ONLY ONE TO BE PLOTTED                 000441
      IF(I.EQ.1) GO TO 11                                              000442
C                                                                      000443
C          SET SCALES FOR THE PLOT                                     000444
      GO TO (12,12,13,14) (IWNTGRD(1)-1)                               000445
14    SCALE=(BASESC/9.)/ROOT2                                          000446
      GO TO 15                                                         000447
13    SCALE=(BASESC/3.)/ROOT2                                          000448
      GO TO 15                                                         000449
12    SCALE=(BASESC/ROOT2)*.4                                          000450
15    IF(IWNTGRD(I-1).EQ.2) GO TO 16                                   000451
      X=-3.*SCALE*ROOT2+(18.+65.)*SCALE/ROOT2                          000452
      Y=-18.*SCALE*ROOT2+(18.-65.)*SCALE/ROOT2                         000453
      GO TO 17                                                         000454
16    X=-28.*SCALE*ROOT2+(18.+65.)*SCALE/ROOT2                         000455
      Y=-23.*SCALE*ROOT2+(18.-65.)*SCALE/ROOT2                         000456
      GO TO 17                                                         000457
11    SCALE=BASESC/ROOT2                                               000458
      Y=29.*SCALE                                                      000459
      X=65.*SCALE                                                      000460
17    CALL PLOT(X,Y,-3)                                                000461
      CALL GRDPLOT(I)                                                  000462
C                                                                      000463
C        SET XUP,YUP TO MAINTAIN THE ORIGIN OF THE PLOT                000464
      XUP=XUP-X                                                        000465
      YUP=YUP-Y                                                        000466
      RETURN                                                           000467
      END                                                              000468
C                                                                      000469
C*****************************************************************      000470
C                                                                      000471
      SUBROUTINE GRDPLOT(K)                                            000472
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                  000473
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                          000474
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                        000475
C                                                                      000476
C        SUBROUTINE TO PLOT THE DESIRED GRID                           000477
C        PEN INSTRUCTIONS ARE INCLUDED IN IGRD                         000478
      J=NPTS(IWNTGRD(K))                                               000479
      DO 120 I=1,J                                                     000480
      IP=2                                                             000481
      XX=-FLOAT(IGRD(3,I,IWNTGRD(K)))*SCALE                            000482
      YY=-FLOAT(IGRD(2,I,IWNTGRD(K)))*SCALE                            000483
      IF(IWNTGRD(K).NE.1) GO TO 20                                     000484
      CALL ROTATE(XX,YY,X,Y,K)                                         000485
      XX=-XX                                                           000486
20    IPEN=IGRD(1,I,IWNTGRD(K))                                        000487
      IF(IPEN.EQ.2) IP=3                                               000488
120   CALL PLOT(XX,YY,IP)                                              000489
      RETURN                                                           000490
      END                                                              000491
C                                                                      000492
C*****************************************************************      000493
C                                                                      000494
      SUBROUTINE TRACK(CNTR,I,J,KGRD)                                  000495
C                                                                      000496
C       SUBROUTINE TO CALCULATE AND PLOT THE CONTOURS IN CELL I,J      000497
      DIMENSION ISET(4),EX(4),EY(4)                                    000498
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                  000499
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                          000500
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                        000501
      X=FLOAT(I)+.5                                                    000502
      Y=FLOAT(J)+.5                                                    000503
C                                                                      000504
C       INITIALIZE ISET, EX, EY, DIST(N)                               000505
      DO 100 K=1,4                                                     000506
      EX(K)=X                                                          000507
      EY(K)=Y                                                          000508
100   ISET(K)=0                                                        000509
      DIST2=10.                                                        000510
      DIST3=10.                                                        000511
      DIST4=10.                                                        000512
C                                                                      000513
C         FIND THE LOCATIONS OF CNTR ON EACH SIDE. SIDES ARE CODED     000514
C        1=TOP, 2=RIGHT, 3=BOTTOM, 4=LEFT                              000515
C           DO SIDE 1 FIRST                                            000516
C         IF IB1=4 THERE ARE NO INTERSECTIONS( ABBREVIATED NTRX) ON     000517
C           SIDES 1 OR 4                                               000518
      IF(IB(1).NE.4) GO TO 1                                           000519
      ISET(4)=1                                                        000520
      GO TO 2                                                          000521
C                                                                      000522
C         CHECK IF IB2=4                                               000523
1     IF(IB(2).EQ.4) GO TO 2                                           000524
C                                                                      000525
C       DETERMINE IF THERE IS AN NTRX                                  000526
      D1=Z(I,J)-CNTR                                                   000527
      D2=Z(I+1,J)-CNTR                                                 000528
      IF(D1.GE.0..AND.D2.LE.0.) GO TO 3                                000529
      IF(D2.GE.0..AND.D1.LE.0.) GO TO 4                                000530
C                                                                      000531
C       NO NTRX ON SIDE 1 GO ON TO SIDE 2                              000532
2     ISET(1)=1                                                        000533
      GO TO 6                                                          000534
C                                                                      000535
C       DETERMINE X,Y OF NTRX                                          000536
3     EX(1)=X+D1/(Z(I,J)-Z(I+1,J))                                     000537
      GO TO 5                                                          000538
4     EX(1)=X+1.-D2/(Z(I+1,J)-Z(I,J))                                  000539
5     EY(1)=Y                                                          000540
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6     CONTINUE                                                                  000541
C                                                                               000542
C      SIDE 2                                                                   000543
C      IF IB2=4 NO NTRX ON SIDES 1 OR 2. SIDE 1 HAS ALREADY                     000544
C       BEEN ACCOUNTED FOR.                                                     000545
      IF(IB(2).EQ.4) GO TO 7                                                    000546
C                                                                               000547
C      CHECK IF IB3=4                                                           000548
      IF(IB(3).NE.4) GO TO 8                                                    000549
      ISET(3)=1                                                                 000550
      GO TO 7                                                                   000551
C                                                                               000552
C      DETERMINE IF THERE IS AN NTRX                                            000553
8     D1=Z(I+1,J)-CNTR                                                          000554
      D2=Z(I+1,J+1)-CNTR                                                        000555
      IF(D1.GE.0..AND.D2.LE.0.) GO TO 9                                         000556
      IF(D2.GE.0..AND.D1.LE.0.) GO TO 10                                        000557
C                                                                               000558
C      NO NTRX ON SIDE 2, GO ON TO SIDE 3                                       000559
7      ISET(2)=1                                                                000560
      GO TO 12                                                                  000561
C                                                                               000562
C       DETERMINE X,Y OF NTRX                                                   000563
9     EY(2)=Y+D1/(Z(I+1,J)-Z(I+1,J+1))                                          000564
      GO TO 11                                                                  000565
10    EY(2)=Y+1.-D2/(Z(I+1,J+1)-Z(I+1,J))                                       000566
11    EX(2)=X+1.                                                                000567
12    CONTINUE                                                                  000568
C                                                                               000569
C      SIDE 3                                                                   000570
C      IF IB3=4 NO NTRX ON SIDES 2 OR 3. SIDE 2 HAS ALREADY                     000571
C      BEEN ACCOUNTED FOR                                                       000572
      IF(IB(3).EQ.4) GO TO 13                                                   000573
C                                                                               000574
C      CHECK IF IB4=4                                                           000575
      IF(IB(4).NE.4) GO TO 14                                                   000576
      ISET(4)=1                                                                 000577
      GO TO 13                                                                  000578
C                                                                               000579
C      DETERMINE IF THERE IS AN NTRX                                            000580
14    D1=Z(I,J+1)-CNTR                                                          000581
      D2=Z(I+1,J+1)-CNTR                                                        000582
      IF(D1.GE.0..AND.D2.LE.0.) GO TO 15                                        000583
      IF(D2.GE.0..AND.D1.LE.0.) GO TO 16                                        000584
C                                                                               000585
C      NO NTRX ON SIDE 3. GO ON TO SIDE 4                                       000586
13    ISET(3)=1                                                                 000587
      GO TO 18                                                                  000588
C                                                                               000589
C      DETERMINE X,Y OF NTRX                                                    000590
15    EX(3)=X+D1/(Z(I,J+1)-Z(I+1,J+1))                                          000591
      GO TO 17                                                                  000592
16    EX(3)=X+1.-D2/(Z(I+1,J+1)-Z(I,J+1))                                       000593
17    EY(3)=Y+1.                                                                000594
18    CONTINUE                                                                  000595
C                                                                               000596
C      SIDE 4                                                                   000597
C      IF IB4=4 NO NTRX ON SIDES 3 OR 4. SIDE 3 HAS ALREADY                     000598
C      BEEN ACCOUNTED FOR.                                                      000599
      IF(IB(4).EQ.4) GO TO 19                                                   000600
      IF(IB(1).EQ.4) GO TO 19                                                   000601
C                                                                               000602
C      IB1 NEED NOT BE CHECKED, IT WAS DONE PREVIOUSLY                          000603
      D1=Z(I,J)-CNTR                                                            000604
      D2=Z(I,J+1)-CNTR                                                          000605
      IF(D1.GE.0..AND.D2.LE.0.) GO TO 20                                        000606
      IF(D2.GE.0..AND.D1.LE.0.) GO TO 21                                        000607
C                                                                               000608
C      NO NTRX ON SIDE 4                                                        000609
19    ISET(4) =1                                                                000610
      GO TO 23                                                                  000611
C                                                                               000612
C      DETERMINE X,Y OF NTRX                                                    000613
20    EY(4)=Y+D1/(Z(I,J)-Z(I,J+1))                                              000614
      GO TO 22                                                                  000615
21    EY(4)=Y+1.-D2/(Z(I,J+1)-Z(I,J))                                           000616
22    EX(4)=X                                                                   000617
23    CONTINUE                                                                  000618
C                                                                               000619
C      IT IS NOW DETERMINED IF NTRX ON THE DIFFERENT SIDES                      000620
C       MAY BE JOINED. THIS DEPENDS ON IF THERE ARE SHORELINES                  000621
C       PRESENT. SIDE 1 IS FIRST CHECKED FOR AN NTRX. IF IT                     000622
C       HAS ONE THE OTHER 3 SIDES ARE CHECKED.                                  000623
      IF(ISET(1).EQ.1) GO TO 150                                                000624
C                                                                               000625
C      SIDE 1 HAS AN NTRX. DOES SIDE 2                                          000626
      IF(ISET(2).EQ.1) GO TO 50                                                 000627
C                                                                               000628
C      SIDE 2 HAS AN NTRX. IS THE CONTOUR A DIAGONAL                            000629
      IF(EX(1).NE.X.OR.EY(2).NE.(Y+1.)) GO TO 51                                000630
C                                                                               000631
C      IF IB3=3 OR 4 NO DIAGONAL IS ALLOWED                                     000632
      IF(IB(3).EQ.3.OR.IB(3).EQ.4) GO TO 52                                     000633
C                                                                               000634
C      IF IB3=1 AND IB4=1,3 OR 4 NO DIAGONAL IS ALLOWED                         000635
      IF(IB(3).NE.1) GO TO 49                                                   000636
      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 52                                    000637
49    DIST2=SQRT(2.)                                                            000638
      GO TO 50                                                                  000639
C                                                                               000640
C      THERE IS NO DIAGONAL CONTOUR. FIND WHERE NTRX1 AND                       000641
C       NTRX2 OCCUR ON SIDES 1 AND 2                                            000642
51    IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 50                                     000643
      IF(IB(3).EQ.1.OR.IB(3).EQ.3) GO TO 50                                     000644
      D1=EX(1)-(X+.5)                                                           000645
      D2=EY(2)-(Y+.5)                                                           000646
      IF(D1.LT.0.) GO TO 48                                                     000647
      IF(D2.GT.0.) GO TO 54                                                     000648
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C
C       CONTOUR FROM RIGHT1 TO TOP2                                     000649
48      DIST2=(EX(1)-EX(2))**2+(EY(1)-EY(2))**2                         000650
        GO TO 50                                                        000651
C                                                                       000652
C       CONTOUR FROM RIGHT1 TO BOTTOM2                                  000653
54      IF(IB(3).NE.4) GO TO 48                                         000654
        GO TO 52                                                        000655
C                                                                       000656
C       CONTOUR FROM LEFT1 TO BOTTOM2                                   000657
52      DIST2=10.                                                       000658
50      CONTINUE                                                        000659
C                                                                       000660
C       SIDE 1 HAS AN NTRX. DOES SIDE 3                                 000661
        IF(ISET(3).EQ.1) GO TO 55                                       000662
C                                                                       000663
C       SIDE 3 HAS AN NTRX. IS THE CONTOUR A DIAGONAL                   000664
        IF(EX(1).NE.X.OR.EX(3).NE.(X+1.)) GO TO 56                      000665
C                                                                       000666
C       DIAGONAL IS TOP LEFT TO BOTTOM RIGHT                            000667
        IF(IB(3).EQ.3) GO TO 57                                         000668
        IF(IB(3).EQ.0) GO TO 59                                         000669
        IF(IB(3).EQ.1) GO TO 58                                         000670
        IF(IB(2).NE.0.AND.IB(2).NE.1) GO TO 57                          000671
59      DIST3=SQRT(2.)                                                  000672
        GO TO 55                                                        000673
58      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000674
        GO TO 59                                                        000675
C                                                                       000676
C       CHECK IF IT IS THE OTHER DIAGONAL                               000677
56      IF(EX(1).NE.(X+1.).OR.EX(3).NE.X) GO TO 60                      000678
C                                                                       000679
C       DIAGONAL IS TOP RIGHT TO BOTTOM LEFT                            000680
        IF(IB(3).EQ.0) GO TO 59                                         000681
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 57                           000682
        IF(IB(4).EQ.0.OR.IB(4).EQ.2) GO TO 59                           000683
        GO TO 57                                                        000684
C                                                                       000685
C       CONTOUR IS NOT A DIAGONAL. FIND OUT WHERE ON                    000686
C         SIDE 1 AND SIDE 3 THE NTRX ARE                                000687
60      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 55                           000688
        IF(IB(3).EQ.2.OR.IB(3).EQ.3) GO TO 55                           000689
        D1=EX(1)-(X+.5)                                                 000690
        D3=EX(3)-(X+.5)                                                 000691
        IF(D1) 61,62,63                                                 000692
63      IF(D3.LT.0.) GO TO 45                                           000693
C                                                                       000694
C       RIGHT1 TO RIGHT3                                                000695
39      IF(IB(3).NE.0) GO TO 57                                         000696
46      DIST3=(EX(1)-EX(3))**2+(EY(1)-EY(3))**2                         000697
        GO TO 55                                                        000698
C                                                                       000699
C       RIGHT1 TO LEFT3. WHAT SIDE OF THE CENTRE POINT DOES             000700
C         THE CONTOUR LIE.                                              000701
45      DD1=X+1.-EX(1)                                                  000702
        DD3=EX(3)-X                                                     000703
        IF(IB(2).EQ.4.OR.IB(4).EQ.4) GO TO 57                           000704
        IF(DD1-DD3) 44,43,42                                            000705
C                                                                       000706
C       RIGHT OF MIDDLE                                                 000707
44      IF(IB(3).NE.0) GO TO 57                                         000708
        GO TO 46                                                        000709
C                                                                       000710
C       THROUGH THE MIDDLE                                              000711
43      IF(IB(3).EQ.0) GO TO 46                                         000712
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 57                           000713
        GO TO 46                                                        000714
C                                                                       000715
C       LEFT OF MIDDLE                                                  000716
42      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000717
        GO TO 46                                                        000718
C                                                                       000719
C       NTRX IN MIDDLE OF SIDE 1                                        000720
62      IF(D3.NE.0.) GO TO 40                                           000721
        IF(IB(3).NE.1) GO TO 46                                         000722
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 57                           000723
        GO TO 46                                                        000724
40      IF(D3.GT.0.) GO TO 39                                           000725
        GO TO 37                                                        000726
C                                                                       000727
C       NTRX ON LEFT HALF OF SIDE 1                                     000728
61      IF(D3.GT.0.) GO TO 38                                           000729
37      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000730
        GO TO 46                                                        000731
C                                                                       000732
C       LEFT1 TO RIGHT3. WHAT SIDE OF THE CENTRE POINT                  000733
C         DOES THE CONTOUR LIE.                                         000734
38      DD1=EX(1)-X                                                     000735
        DD3=X+1.-EX(3)                                                  000736
        IF(DD1-DD3) 36,33,34                                            000737
C                                                                       000738
C       LEFT OF MIDDLE                                                  000739
36      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000740
        GO TO 46                                                        000741
C                                                                       000742
C          THROUGH THE MIDDLE                                           000743
33      IF(IB(3).NE.1) GO TO 46                                         000744
        IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000745
        GO TO 46                                                        000746
C                                                                       000747
C       RIGHT OF MIDDLE                                                 000748
34      IF(IB(3).NE.0) GO TO 57                                         000749
        IF(IB(2).EQ.0.OR.IB(2).EQ.1) GO TO 46                           000750
57      DIST3=10.                                                       000751
55      CONTINUE                                                        000752
C                                                                       000753
C       SIDE 1 HAS AN NTRX. DOES SIDE 4.                                000754
        IF(ISET(4).EQ.1) GO TO 66                                       000755
                                                                        000756
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C                                                                       000757
C       CHECK IF THE CONTOUR IS A DIAGONAL                              000758
        IF(EX(1).NE.(X+1).OR.EY(4).NE.(Y+1.)) GO TO 64                  000759
C                                                                       000760
C         IS THE DIAGONAL ALLOWED.                                      000761
        IF(IB(3).EQ.0) GO TO 300                                        000762
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 65                           000763
        IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 65                          000764
300     DIST4=SQRT(2.)                                                  000765
        GO TO 66                                                        000766
C                                                                       000767
C       NO DIAGONAL. FIND OUT WHERE THE NTRX ARE ON SIDES               000768
C         1 AND 4                                                       000769
64      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 66                           000770
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 66                           000771
        D1=EX(1)-(X+.5)                                                 000772
        D2=EY(4)-(Y+.5)                                                 000773
        IF(D1.GT.0.) GO TO 68                                           000774
C                                                                       000775
C       NTRX ON LEFT HALF OF SIDE 1                                     000776
        GO TO 68                                                        000777
C                                                                       000778
C       RIGHT HALF OF SIDE 1, BOTTOM HALF OF SIDE 4                     000779
68      DIST4=(EX(1)-EX(4))**2+(EY(1)-EY(4))**2                         000780
        GO TO 66                                                        000781
65      DIST4=10.                                                       000782
66      CONTINUE                                                        000783
C                                                                       000784
C       NOW FIND THE CLOSEST NTRX                                       000785
        IF(DIST2-DIST3) 70,72,72                                        000786
72      IF(DIST3-DIST4) 74,73,73                                        000787
70      IF(DIST2-DIST4) 75,73,73                                        000788
73      XX=EX(4)*SCALE                                                  000789
        YY=EY(4)*SCALE                                                  000790
        X1=EX(2)*SCALE                                                  000791
        Y1=EY(2)*SCALE                                                  000792
        X2=EX(3)*SCALE                                                  000793
        Y2=EY(3)*SCALE                                                  000794
        IF((DIST2+DIST3+DIST4).GE.30.) GO TO 250                        000795
        GO TO 80                                                        000796
74      XX=EX(3)*SCALE                                                  000797
        YY=EY(3)*SCALE                                                  000798
        X1=EX(2)*SCALE                                                  000799
        Y1=EY(2)*SCALE                                                  000800
        X2=EX(4)*SCALE                                                  000801
        Y2=EY(4)*SCALE                                                  000802
        GO TO 80                                                        000803
75      XX=EX(2)*SCALE                                                  000804
        YY=EY(2)*SCALE                                                  000805
        X1=EX(3)*SCALE                                                  000806
        Y1=EY(3)*SCALE                                                  000807
        X2=EX(4)*SCALE                                                  000808
        Y2=EY(4)*SCALE                                                  000809
80      X=EX(1)*SCALE                                                   000810
        Y=EY(1)*SCALE                                                   000811
        IF((DIST2+DIST3+DIST4).GE.30.) GO TO 250                        000812
        CALL ROTATE(XX,YY,X,Y,KGRD)                                     000813
301     CALL PLOT(X,Y,3)                                                000814
        CALL PLOT(XX,YY,2)                                              000815
C                                                                       000816
C         CHECK IF THERE ARE 4 NTRX IN THIS BOX. IF SO,                 000817
C         JOIN THE 2 CLOSEST POINTS AND THEN JOIN THE                   000818
C         OTHER 2 POINTS                                                000819
        IF(DIST2.GE.10..OR.DIST3.GE.10..OR.DIST4.GE.10.) GO TO 249      000820
        CALL ROTATE(X1,Y1,X2,Y2,KGRD)                                   000821
        CALL PLOT(X1,Y1,3)                                              000822
        CALL PLOT(X2,Y2,2)                                              000823
        GO TO 249                                                       000824
C                                                                       000825
C       SIDE 1 HAS NO NTRX. DOES SIDE 2.                                000826
150     IF(ISET(2).EQ.1) GO TO 200                                      000827
C                                                                       000828
C       SIDE 2 HAS AN NTRX. DOES SIDE 3.                                000829
        IF(ISET(3).EQ.1) GO TO 90                                       000830
C                                                                       000831
C       IS THE CONTOUR A DIAGONAL.                                      000832
        IF(EY(2).NE.Y.OR.EX(3).NE.X) GO TO 91                           000833
C                                                                       000834
C       CONTOUR IS A DIAGONAL.                                          000835
        IF(IB(3).EQ.0) GO TO 88                                         000836
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 92                           000837
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 92                           000838
88      DIST3=SQRT(2.)                                                  000839
        GO TO 90                                                        000840
C                                                                       000841
C       CONTOUR IS NOT A DIAGONAL. FIND OUT WHERE THE NTRX              000842
C         IS ON SIDE 2 AND SIDE 3.                                      000843
91      IF(IB(3).NE.0) GO TO 90                                         000844
        D2=EY(2)-(Y+.5)                                                 000845
        D3=EX(3)-(X+.5)                                                 000846
        IF(D2.LT.0.) GO TO 93                                           000847
C                                                                       000848
C       NTRX IS ON THE BOTTOM HALF OF SIDE 2                            000849
        IF(IB(3).NE.0) GO TO 92                                         000850
96      DIST3=(EX(2)-EX(3))**2+(EY(2)-EY(3))**2                         000851
        GO TO 90                                                        000852
C                                                                       000853
C       NTRX IS ON THE TOP HALF OF SIDE 2                               000854
93      IF(D3.LT.0.) GO TO 94                                           000855
C                                                                       000856
C       NTRX IS ON THE RIGHT HALF OF SIDE 3                             000857
        IF(IB(3).EQ.0) GO TO 96                                         000858
        GO TO 92                                                        000859
C                                                                       000860
C       NTRX IS ON THE LEFT HALF OF SIDE 3                              000861
94      IF(IB(3).EQ.0) GO TO 96                                         000862
92      DIST3=10.                                                       000863
90      CONTINUE                                                        000864
```

```
C                                                                       000865
C       SIDE 2 HAS AN NTRX. DOES SIDE 4.                                000866
        IF(ISET(4).EQ.1) GO TO 120                                      000867
C                                                                       000868
C       IS THE CONTOUR A DIAGONAL.                                      000869
        IF(EY(2).EQ.Y.AND.EY(4).EQ.(Y+1)) GO TO 105                     000870
        IF(EY(2).NE.(Y+1).OR.EY(4).NE.Y) GO TO 106                      000871
C                                                                       000872
C       DIAGONAL IS TOP LEFT TO BOTTOM RIGHT                            000873
        IF(IB(3).EQ.3) GO TO 107                                        000874
        IF(IB(3).EQ.2.AND.IB(2).EQ.2) GO TO 107                         000875
        IF(IB(3).EQ.2.AND.IB(2).EQ.3) GO TO 107                         000876
        IF(IB(3).EQ.0) GO TO 89                                         000877
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 107                          000878
89      IF(IB(2).NE.2.AND.IB(3).NE.3) GO TO 109                         000879
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 107                          000880
109     DIST4=SQRT(2.)                                                  000881
        GO TO 120                                                       000882
C                                                                       000883
C       DIAGONAL IS TOP RIGHT TO BOTTOM LEFT                            000884
105     IF(IB(3).EQ.0) GO TO 109                                        000885
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                          000886
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 107                          000887
        GO TO 109                                                       000888
C                                                                       000889
C       CONTOUR IS NOT A DIAGONAL. FIND OUT WHERE ON SIDES              000890
C         2 AND 4 THE NTRX ARE.                                         000891
106     IF(IB(3).EQ.1.OR.IB(3).EQ.3) GO TO 120                          000892
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 120                          000893
        D2=EY(2)-(Y+.5)                                                 000894
        D4=EY(4)-(Y+.5)                                                 000895
        IF(D2.GT.0.) GO TO 110                                          000896
C                                                                       000897
C       NTRX IS ON THE TOP HALF OF SIDE 2                               000898
        IF(D4.GT.0.) GO TO 111                                          000899
C                                                                       000900
C       NTRX IS ON THE TOP HALF OF SIDE 4                               000901
        IF(D2.NE.0..AND.D4.NE.0.) GO TO 112                             000902
C                                                                       000903
        IF(IB(3).EQ.2.AND.IB(2).EQ.2) GO TO 107                         000904
        IF(IB(2).EQ.1.OR.IB(2).EQ.0) GO TO 114                          000905
        GO TO 114                                                       000906
112     IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                          000907
114     DIST4=(EX(2)-EX(4))**2+(EY(2)-EY(4))**2                         000908
        GO TO 120                                                       000909
C                                                                       000910
C       CONTOUR RUNS FROM TOP2 TO BOTTOM4                               000911
111     DD2=EY(2)-Y                                                     000912
        DD4=Y+1.-EY(4)                                                  000913
        IF((DD4-DD2).GE.0.) GO TO 113                                   000914
C                                                                       000915
C       CONTOUR RUNS BELOW MIDDLE OF CELL                               000916
        IF(IB(3).NE.0) GO TO 107                                        000917
        GO TO 114                                                       000918
C                                                                       000919
C       CONTOUR RUNS THROUGH OR ABOVE MIDDLE                            000920
113     IF(DD4.NE.DD2) GO TO 115                                        000921
C                                                                       000922
C       CONTOUR RUNS THROUGH THE MIDDLE                                 000923
        IF(IB(3).EQ.0) GO TO 114                                        000924
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                          000925
        GO TO 114                                                       000926
C                                                                       000927
C       CONTOUR RUNS ABOVE MIDDLE                                       000928
115     IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                          000929
        GO TO 114                                                       000930
C                                                                       000931
C       NTRX IS ON THE BOTTOM HALF OF SIDE 2                            000932
110     IF(D4.LT.0.) GO TO 117                                          000933
C                                                                       000934
C       CONTOUR IS ON THE BOTTOM HALF OF SIDE 4                         000935
        GO TO 114                                                       000936
C                                                                       000937
C       CONTOUR RUNS FROM  BOTTOM2 TO TOP4                              000938
117     DD4=EY(4)-Y                                                     000939
        DD2=Y+1.-EY(2)                                                  000940
        IF((DD4-DD2).LE.0.) GO TO 118                                   000941
C                                                                       000942
C       CONTOUR RUNS BELOW MIDDLE OF CELL                               000943
        IF(IB(3).EQ.2) GO TO 107                                        000944
        GO TO 114                                                       000945
C                                                                       000946
C       CONTOUR RUNS THROUGH OR ABOVE MIDDLE                            000947
118     IF(DD2.NE.DD4) GO TO 119                                        000948
C                                                                       000949
C       CONTOUR RUNS THROUGH MIDDLE OF CELL                             000950
        IF(IB(2).NE.2.AND.IB(2).NE.3) GO TO 114                         000951
        IF(IB(3).EQ.2) GO TO 107                                        000952
        GO TO 114                                                       000953
C                                                                       000954
C       CONTOUR RUNS ABOVE MIDDLE                                       000955
119     IF(IB(2).NE.2.AND.IB(2).NE.3) GO TO 114                         000956
107     DIST4=10.                                                       000957
120     CONTINUE                                                        000958
C                                                                       000959
C       DETERMINE THE CLOSEST NTRX                                      000960
        IF(DIST3.GE.DIST4) GO TO 121                                    000961
        XX=EX(3)*SCALE                                                  000962
        YY=EY(3)*SCALE                                                  000963
        GO TO 122                                                       000964
121     XX=EX(4)*SCALE                                                  000965
        YY=EY(4)*SCALE                                                  000966
122     X=EX(2)*SCALE                                                   000967
        Y=EY(2)*SCALE                                                   000968
        IF((DIST3+DIST4).GE.20.) GO TO 250                              000969
        CALL ROTATE(XX,YY,X,Y,KGRD)                                     000970
303     CALL PLOT(XX,YY,3)                                              000971
        CALL PLOT(X,Y,2)                                                000972
```

```
      GO TO 249                                                          000973
C                                                                        000974
C      SIDE 2 HAS NO NTRX. DOES SIDE 3.                                  000975
200   IF(ISET(3).EQ.1) GO TO 250                                         000976
C                                                                        000977
C      SIDE 3 HAS AN NTRX. DOES SIDE 4.                                  000978
      IF(ISET(4).EQ.1) GO TO 250                                         000979
C                                                                        000980
C      IS THE CONTOUR A DIAGONAL.                                        000981
      IF(EY(4).NE.Y.OR.EX(3).NE.(X+1.)) GO TO 130                        000982
      IF(IB(3).EQ.3) GO TO 250                                           000983
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 131                             000984
      IF(IB(3).NE.0.AND.IB(3).NE.1) GO TO 132                            000985
133   DIST4=SQRT(2.)                                                     000986
      GO TO 249                                                          000987
132   IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 250                             000988
      GO TO 133                                                          000989
131   IF(IB(3).EQ.1.OR.IB(3).EQ.3) GO TO 250                             000990
      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 250                             000991
      GO TO 133                                                          000992
C                                                                        000993
C      CONTOUR IS NOT A DIAGONAL. FIND WHERE ON SIDES                    000994
C        THE NTRX ARE                                                    000995
130   IF(IB(3).EQ.2.OR.IB(3).EQ.3) GO TO 250                             000996
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 250                             000997
135   X=EX(3)*SCALE                                                      000998
      Y=EY(3)*SCALE                                                      000999
      XX=EX(4)*SCALE                                                     001000
      YY=EY(4)*SCALE                                                     001001
      CALL ROTATE(XX,YY,X,Y,KGRD)                                        001002
302   CALL PLOT(XX,YY,3)                                                 001003
      CALL PLOT(X,Y,2)                                                   001004
C                                                                        001005
C      LABEL THE PLOTS                                                   001006
249   CONTINUE                                                           001007
      XX=XX+.04                                                          001008
      YY=YY+.04                                                          001009
      IF(NDATA.EQ.1) GO TO 252                                           001010
      IF(IWNTGRD(KGRD).NE.5.AND.IWNTGRD(KGRD).NE.4) GO TO 250            001011
      IF(MOD(I,5).NE.0) GO TO 250                                        001012
      IF(MOD(J,5).NE.0) GO TO 250                                        001013
      CALL NUMBER(XX,YY,.28,CNTR,0.,-1)                                  001014
      GO TO 250                                                          001015
252   IF(IWNTGRD(KGRD).EQ.5.OR.IWNTGRD(KGRD).EQ.4) GO TO 253             001016
      IF(MOD(I,6).NE.0) GO TO 250                                        001017
      IF(MOD(J,6).NE.0) GO TO 250                                        001018
      CALL NUMBER(XX,YY,.28,CNTR,0.,-1)                                  001019
      GO TO 250                                                          001020
253   IF(MOD(I,4).NE.0) GO TO 250                                        001021
      IF(MOD(J,4).NE.0) GO TO 250                                        001022
      CALL NUMBER(XX,YY,.28,CNTR,0.,-1)                                  001023
250   CONTINUE                                                           001024
      RETURN                                                             001025
      END                                                                001026
C                                                                        001027
C*********************************** ***************************        001028
C                                                                        001029
      SUBROUTINE CELLIJ(I,NVC)                                           001030
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                    001031
      COMMON E(29,65),IB(4),CONTOUR(30),SCALE                            001032
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                          001033
C                                                                        001034
C      READ THE CODES FOR THE SHORELINE                                  001035
      DO 100 K=1,5                                                       001036
      READ(2,101) IGRDNO,IST(K),IND(K)                                   001037
101   FORMAT(4X,I2,2I3)                                                  001038
      IEND=IST(K)                                                        001039
      JEND=IND(K)                                                        001040
      DO 102 J=1,JEND                                                    001041
      ENCODE(10,110,FMT)IEND                                             001042
110   FORMAT(1H(,I3,3HI1))                                               001043
102   READ(2,FMT) (IEDGE(II,J,K),II=1,IEND)                              001044
100   CONTINUE                                                           001045
      ENTRY CELL                                                         001046
C                                                                        001047
C      SET THE CODES FOR THE BOX TO BE CONSIDERED                        001048
      IEND=IST(IWNTGRD(I))-1                                             001049
      JEND=IND(IWNTGRD(I))-1                                             001050
      DO 103 J=1,IEND                                                    001051
      DO 103 K=1,JEND                                                    001052
      IB(1)=IEDGE(J,K,IWNTGRD(I))                                        001053
      IB(2)=IEDGE(J+1,K,IWNTGRD(I))                                      001054
      IB(3)=IEDGE(J+1,K+1,IWNTGRD(I))                                    001055
      IB(4)=IEDGE(J,K+1,IWNTGRD(I))                                      001056
C                                                                        001057
C      CHECK IF 2 OR MORE IB EQUAL 4. IF SO PROCEED                      001058
C        TO THE NEXT CELL                                                001059
      DO 104 JK=2,4                                                      001060
104   IF((IB(1)+IB(JK)).EQ.8) GO TO 103                                  001061
      DO 105 JK=3,4                                                      001062
105   IF((IB(2)+IB(JK)).EQ.8) GO TO 103                                  001063
      IF((IB(3)+IB(4)).EQ.8) GO TO 103                                   001064
      DO 106 KK=1,NVC                                                    001065
      CNTR=CONTOUR(KK)                                                   001066
      CALL TRACK(CNTR,J,K,I)                                             001067
106   CONTINUE                                                           001068
103   CONTINUE                                                           001069
      RETURN                                                             001070
      END                                                                001071
C                                                                        001072
C*************************************************************          001073
C                                                                        001074
      SUBROUTINE ROTATE(XX,YY,X,Y,KGRD)                                  001075
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                    001076
      COMMON E(29,65),IB(4),CONTOUR(30),SCALE                            001077
      COMMON IST(5),IND(5),IEDGE(29,65,5),NDATA                          001078
      ROOT2=SQRT(2.)                                                     001079
      X1=-YY                                                             001080
```

```
      Y1=-XX
      X2=-Y                                                          001081
      Y2=-X                                                          001082
      IF(IWNTGRD(KGRD).NE.1) GO TO 1                                 001083
      XX=X1/ROOT2+Y1/ROOT2                                           001084
      YY=Y1/ROOT2-X1/ROOT2                                           001085
      X=X2/ROOT2+Y2/ROOT2                                            001086
      Y=Y2/ROOT2-X2/ROOT2                                            001087
      GO TO 2                                                        001088
1     XX=X1                                                          001089
      YY=Y1                                                          001090
      X=X2                                                           001091
      Y=Y2                                                           001092
2     CONTINUE                                                       001093
      RETURN                                                         001094
      END                                                            001095
                                                                     001096
```

```
ILVBK,CM130000,T100,MT2,P2. BOB KEELEY                                          000001
ACCOUNT,*****.                                                                  000002
ATTACH,A,BKENERGYX,ID=MEDS.                                                     000003
ATTACH,TAPE11,DGFUNDY1E,ID=MEDS.                                                000004
LABEL,TAPE15,R,L=DGDXR11,T=999,X=SV.ER0143                                      000005
FTN,I=A,L=0.                                                                    000006
LGO.                                                                            000007
RETURN,A,TAPE11,TAPE15,LGO.                                                     000008
ATTACH,A,BKBFNRGX,ID=MEDS,CY=4.                                                 000009
ATTACH,TAPE1,BRBFGRIDX,ID=MEDS.                                                 000010
ATTACH,TAPE2,BKNRGEDGEX,ID=MEDS.                                                000011
ATTACH,LIB,MEDSPLIB,ID=MEDSPLIB,MR=1.                                           000012
LIBRARY,LIB.                                                                    000013
REQUEST,TAPE10,HY,S,SV,MT.MOUNT OCEANPLOT TAPE RETURN KEELEY STOP 1.            000014
FTN,I=A,L=0.                                                                    000015
LGO.                                                                            000016
1.005&3211.00                                                                   000018
RUN EX40                                                                        000019
    15                                                                          000020
1000. 900. 800. 700. 600.                                                       000021
 500. 400. 300. 200. 100.                                                       000022
  80.  60.  40.  20.   0.                                                       000023
    8                                                                           000024
3000.1000. 500. 250. 100.                                                       000025
 100.  50.  20.                                                                 000026
   10                                                                           000027
1000. 750. 500. 250. 100.                                                       000028
  50.  25.  10.   5.   1.                                                       000029
```

APPENDIX B: Coding for BRBFGRIDX

```
GRID 05 76
204,09 04,13 03,13 03,15204,14 03,14203,15 02,15 02,17
 03,17203,16 04,16203,17 03,21 02,21 02,22 03,22 03,24
 04,24 04,26 06,26 06,28 11,28 11,26 09,26213,28 12,28
211,27 10,27 10,29 09,29211,29 11,30209,29 09,30 10,30
 10,31 08,31 08,32 09,32 09,34 16,34 16,33 17,33 17,32
 18,32 18,31 19,31 19,30 20,30 20,26 21,26 21,22 22,22
 22,18 21,18 21,16 20,16 20,13 19,13 19,04 20,04 20,02
 19,02 19,01 12,01 12,04 13,04 13,06 12,06 12,07 13,07
 13,08 11,08 11,09 10,09
GRID 04 56
209,02109,09 08,09 08,10 07,10 07,16 06,16 06,18 05,18
 05,20 04,20 04,19 03,19 03,20 02,20 02,22 05,22 05,23
 07,23 07,21 06,21205,21104,21203,21102,21207,23107,24
210,24110,21 08,21209,21109,23 10,23210,22111,22225,24
125,23 23,23 23,22 21,22 21,21 20,21 20,20 19,20 19118
 18,18 18,15 17,15 17,20 13,20 18,22217,17116117 16,02
205,22 06,22
GRID 03 35
223,17123,07 24,07 24,04 25,04 25,03218,03118,05 17,05
 17,04 16,04 16,05 14,05 14,09216,12116,13214,08113,08
 13,07 11,07 11,05 10,05 10,02 09,02202,17102,11 03,11
202,11102,10 03,10 03,06 04,06 04,03 03,03 03,02
GRID 02 51
208,27108,23 09,23 09,22 11,22 11,21 10,21 10,18 09,18
 09,16 08,16 08,15 09,15 07,15 07,12 06,12 06,10 02,10
 02,09 04,09 04,08 05,08 05,09 06,09 06,08 08,08 08,09
 09,09 09,11 10,11 10112 11,12 11,10 10,10 10,06 09,06
 09,02 12,02 12,03 11,03 11,06 12,06 12,09 13,09 13,12
 14,12 14,19 15,19 15,25 14,25 14,27
GRID 01144
218,65118,64 14,64 14,63 13,63 13,62 12,62 12,60 11,60
 11,54 10,54 10,53 11,53 11,51 12,51 12,49 11,49 11,47
 09,47 09,46 10,46 10,43 08,43 08,41 07,41 07,37 06,37
 06,35 07,35207,36108,36 08,35207,35107,32 06,32 06,28
 08,28 08,26 06,26 06,25 05,25 05,23 04,23 04,21 03,21
 03,20 04,20 04,17 03,17 03,08 02,08 02,06 03,06 03,05
 02,05 02,02 03,02 03,04 04,04 04,05 05,05 05,06 07,06
 07,07 06,07 06,10 07,10 07,12 08,12 08,18 10,18 10,20
 09,20 09,21 10,21 10,22 12,22 12,24 13,24 13,26 14,26
 14,28 15,28 15,29 16,29 16,30 17,30 17,33 18,33 18,34
 19,34 19,35 20,35 20,36 21,36 21,37 24,37 24,38 26,38
 26,30 29,30 29,31 27,31 27,40 26,40275,41125,41226,40
126,44 29,44 29,45 28,45 28,46 25,46 25,45 24,45 24,46
 23,46 23,47 22,47 22,46 18,46 18,45 17,45 17,46 15,46
 15,55215,52116,52 16,49 18,49 18,50 20,50 20,51 21,51
 21,53 22,53 22,55 23,55 23,56 24,56 24,57 25,57 25,58
GRID  1 76
 2,02,02 2,02,03 2,03,04 3,04,05 2,06,06 2,05,07 3,05,08
 3,05,09 3,06,10 3,06,11 3,07,12 3,07,13 3,07,14 3,07,15
 3,07,16 4,07,17 4,09,18 4,09,19 3,08,20 4,09,21 4,11,22
 5,11,23 5,12,24 6,12,25 8,13,26 8,13,27 6,14,28 6,15,29
 6,16,3026,28,30 6,16,3145,26,31 7,16,3226,26,32 7,17,33
26,26,33 7,18,3426,26,34 6,19,3526,26,35 6,20,3626,26,36
 7,23,3726,26,37 7,26,38 7,26,39 7,25,40 8,25,41 8,25,42
10,25,4310,28,4410,16,4518,23,4525,27,45 9,14,4622,22,46
11,14,4711,14,4812,14,4916,17,4912,14,5016,19,5011,14,51
16,20,5111,20,5210,21,5311,21,.411,22,5511,23,5611,24,57
11,23,5811,22,5912,21,6012,20,6113,19,6214,18,63
GRID  2 30
 9,11,02 9,10,03 9,10,04 9,10,0510,11,0610,11,07 4,04,08
 6,07,0810,11,08 2,08,0910,12,09 6,08,1011,12,10 6,09,11
11,12,11 7,13,12 7,13,13 7,13,14 8,13,15 9,13,16 9,13,17
10,13,1810,14,1910,14,2011,14,21 9,14,22 8,14,23 8,14,24
 8,13,25 8,13,26
GRID  3 21
 3,09,02 4,09,0318,24,03 4,09,0416,16,0418,23,04 4,10,05
14,23,05 3,10,0614,23,06 3,12,0714,22,07 3,22,08 3,22,09
 2,22,10 2,22,11 2,22,12 2,22,13 2,22,14 2,22,15 2,22,16
GRID  4 27
 9,15,02 9,15,03 9,15,04 9,15,05 9,15,06 9,15,07 9,15,08
 8,15,09 7,15,10 7,15,11 7,15,12 7,15,13 7,15,14 7,15,15
17,17,15 6,15,1617,17,16 6,17,17 5,18,18 3,03,19 5,18,19
 2,19,20 2,08,2110,20,21 5,08,2210,22,22 7,24,23
GRID  5 32
12,18,0212,18,0313,17,0413,17,0512,17,0613,17,0711,17,08
04,17,0904,17,1004,17,1104,17,1203,18,1303,18,1402,18,15
02,19,1603,19,1703,20,1803,20,1903,20,2002,20,2103,19,22
03,19,2304,19,2404,19,2506,18,2606,09,2711,18,2710,18,28
09,18,2910,17,3008,16,3109,15,32
```

```
**************   FOR BARRIER A6 **************
      GRID 02 55
       14,12 14,19 15,19 15,25 14,27209,15 09,14 10,14
*******  INSERT AFTER LINE 30 *******
       10,12
**************  FOR BARRIER A8 **************
      GRID 02 54
       14,12 14,19 15,19 15,25 14,25 14,27211,10 12,10 12,09
**************  FOR BARRIER B6 **************
      GPID 01150
*******  INSERT AFTER LINE 47 *******
      208,41 17,41 17,39 19,39 19,37 21,37
**************  FOR BARRIER B9 **************
      GRID 01146
*******  INSERT AFTER LINE 47 *******
      208,26 13,26
```

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000024
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APPENDIX C: Coding for BKNRGEDGEX

The shoreline coding system is as follows:

1. All grid units not covered by water or in which no contours are desired are given a value of 4.

2. All grid units with a shoreline along the top and left hand sides are given a value of 3.

3. All grid units with a shoreline along the left hand side are given a value of 2.

4. All grid units with a shoreline along the top are given a value of 1.

5. All grid units with no shorelines along the top or left hand sides are given a value of 0.

A listing of the coding used and the alterations required to simulate barriers follows.

```
GRID 1 29 65
4444444444444444444444444444444
4344444444444444444444444444444
4244444444444444444444444444444
4214444444444444444444444444444
4421444444444444444444444444444
4301144444444444444444444444444
4200044444444444444444444444444
4420044444444444444444444444444
4420044444444444444444444444444
4420014444444444444444444444444
4420044444444444444444444444444
4420001444444444444444444444444
4420000444444444444444444444444
4420000444444444444444444444444
4420000444444444444444444444444
4420000444444444444444444444444
4442000444444444444444444444444
4442000114444444444444444444444
4442000004444444444444444444444
4430000044444444444444444444444
4442000014444444444444444444444
4442000001144444444444444444444
4444200000044444444444444444444
4444200000014444444444444444444
4444420000000444444444444444444
4444420000000014444444442444444
4444442000000044444444442444444
4444442000000001444444442444444
4444442000000000144444442444444
4444430200000000014444442444444
4444421000000000001444442444444
4444442000000000001114442444444
4444442000000000000000110444444
4444442000000000000000000444444
4444442000000000000000000044444
4444442000000000000000014444444
4444444200000000000000004444444
4444444420000000000000001114444
4444444442000000042000004200444
4444444430000044444442444444444
4444444444200044444444444444444
4444444444200444444444444444444
4444444444420043144444444444444
4444444444442004201144444444444
4444444444300042000184444444444
4444444444200030000044444444444
4444444443000020000014444444444
4444444444200620000004444444444
4444444444200000060001444444444
4444444444200000000001444444444
4444444444200000000001444444444
4444444444200000000004444444444
4444444444200000000044444444444
4444444444420000000044444444444
4444444444442000004444444444444
4444444444444444444444444444444
4444444444444444444444444444444
GRID 2 15 28
444444444444444
444444431144444
444444442044444
444444442044444
444444442044444
444444442144444
444444442044444
444384314842044444
431010014201444
444442004420444
444442001420444
444442001001444
444442000000444
444442000000444
444443000000444
444444420000444
444444420000444
444444420002444
444444420004444
444444420004444
444444420004444
444444431000044
444444430000044
444444420000044
444444420000044
444444444444444
444444444444444
GRID 3 25 18
442000004444444444444444
442000001444444442000000444
442000000444444442000000444
442000001444443420000044444
442000001444431010000044444
443000000044420000000044444
442000000114200000000444444
442000000001200000000444444
442000000000000000000444444
430000000000000000000444444
430000000000000000000444444
420000000000002000000444444
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4200000000000000000000444
4200000000000000000000444
4200000000000000000000444
4200000000000000000000444
4200000000000000000000444
4200000000000000000000444
GRID 4 25 25
4444444444444444444444444
4444444420000004444444444
4444444420000004444444444
4444444420000004444444444
4444444420000004444444444
4444444420000004444444444
4444444420000004444444444
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4444444420000004444444444
4444444420000004444444444
4444444420000004444444444
4444444420000000043444444444
4444430000000004244444444
4444420000000001244444444
4444300000000000214444444
4434200000000000204444444
4301000000000000121444444
4301012142000000020144444
4444302043000000000114444
4444442012000000000000114
4444442000000003000000000
4444442000000000000000000
GRID 5 22 33
444444444442000004444
444444444442000004444
444444444442000004444
444444444442000004444
444444444442000004444
444444444430000004444
444444444442000004444
444444444431000004444
444200000100000004444
444200000000000004444
444200000000000004444
444200000000000004444
443000000000000000444
443000000000000000444
430000000000000000444
421000000000000000044
442000000000000000044
442000000000000000004
442000000000000000004
442000000000000000004
442000000000000000004
430000000002000000004
442000000000000000044
442000000000000000044
442000000000000000044
442000000000000000044
444442001120000000444
444442000420000000444
444444444301000000444
444444443020000000444
444444444200000004444
444444431000000044444
444444442000000044444
444444442000000444444
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```

```
********** FOR BARRIER A6 **********
      4444442003001444                                          000079
      4444442002000444                                          000080
      4444442030000444                                          000081
-
********** FOR BARRIER A8 **********
      4310001823144                                             000076
-
********** FOR BARRIER B6 **********
      444444200000000003111144244                               000038
      444444200000000000200001104444                            000039
      444444200000000031000000004444                            000040
      444444200000000020000000044444                            000041
      444444431111111100000000144444                            000042
-
-
********** FOR BARRIER B9 **********
      444444431111144444444444444444                            000027
```

APPENDIX D: Interpolation Schemes

Greenberg's numerical model of the Bay of Fundy divided the system into 5 grids. In each of these grids, values at sea boundaries were set equal to zero. Values for elevation and current velocity were calculated so that the grids fitted together with no overlap. To ensure smooth contouring across grid boundaries it was necessary to do some interpolation at the grid boundaries.

Where grid sizes did not change across a boundary a simple linear interpolation between adjacent units in either grid was used. Where there was a scale change, the finer grid was extended until it overlapped the centre of a grid unit in the first row of values in the coarse grid. Values were interpolated linearly along the lines joining the centres of units in the line and coarse grids. The remaining values in the extended fine grid were defined by a linear interpolation from the above calculated values.

At the open sea boundary of the grid representing the Gulf of Maine, values on the boundary were determined by a linear extrapolation from interior values.

APPENDIX E: Source Listing and Sample Run of Program BFCAP

```
      PROGRAM BFCAP(INPUT,OUTPUT,TAPE1,TAPE10,TAPE2,TAPE3)                    000001
      DIMENSION Z1(29,65),Z2(15,28),Z3(25,17),Z4(25,24),Z5(22,33)             000002
      DIMENSION BUFF(1),CONT(2,30),NVC1(2)                                    000003
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                         000004
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                                 000005
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                               000006
      REWIND 2                                                                000007
      REWIND 3                                                                000008
      REWIND 1                                                                000009
C                                                                             000010
C        READ BAY OF FUNDY GRID COORDINATES FROM TAPE 1                       000011
      DO 100 I=1,5                                                            000012
      KJ=6-I                                                                  000013
      READ(1,500) IGRDNO,NPTS(KJ)                                             000014
500   FORMAT(5X,I2,I3)                                                        000015
501   FORMAT(9(I1,I2,1X,I2))                                                  000016
      J=NPTS(KJ)                                                              000017
100   READ(1,501) ((IGRD(II,JJ,KJ),II=1,3),JJ=1,J)                            000018
C                                                                             000019
C        READ BASESC, IWNTGRD, FAC FROM INPUT                                 000020
      PRINT 876                                                               000021
876   FORMAT(* *,*INPUT,BASESC,IWNTGRD, FAC*)                                 000022
      READ 502,BASESC,(IWNTGRD(I),I=1,5),FAC                                  000023
502   FORMAT(F4.2,5I1,F4.2)                                                   000024
      PRINT 800,BASESC,(IWNTGRD(I),I=1,5),FAC                                 000025
800   FORMAT(* *,*BASESC**,F6.2,* IWNTGRD**,5I2,*  FACTOR**,F6.2)             000026
      PRINT 181                                                               000027
181   FORMAT(* *,*INPUT: CONTOUR(6F7.2)*)                                     000028
      READ 806,NVC1(1)                                                        000029
      MP=NVC1(1)                                                              000030
      READ 805,(CONT(1,J),J=1,MP)                                             000031
      READ 806,NVC1(2)                                                        000032
      MP=NVC1(2)                                                              000033
      READ 805,(CONT(2,J),J=1,MP)                                             000034
806   FORMAT(I5)                                                              000035
805   FORMAT(6F7.2)                                                           000036
801   FORMAT(* *,*VALUES CONTOURED **,6F7.1)                                  000037
C                                                                             000038
C        INITIALIZE PLOT ROUTINE AND SET ORIGIN TO THE BOTTOM LEFT            000039
C         HAND CORNER. PLOT IS WRITTEN ON TAPE 10.                            000040
      CALL PLOTS(BUFF,200,10)                                                 000041
C                                                                             000042
C       FACTOR SCALES THE WHOLE PLOT                                          000043
      CALL FACTOR(FAC)                                                        000044
      XUP=0.                                                                  000045
      YUP=0.                                                                  000046
      CALL PLOT(10.,-30.,-3)                                                  000047
      CALL PLOT(3.,3.,-3)                                                     000048
      DO 779 IFLAG=1,2                                                        000049
      READ(3) Z1,Z2,Z3,Z4,Z5                                                  000050
      CALL PLOT(XUP,YUP,-3)                                                   000051
      XUP=0.                                                                  000052
      YUP=0.                                                                  000053
      NVC=NVC1(IFLAG)                                                         000054
      DO 67 I=1,NVC                                                           000055
67    CONTOUR(I)=CONT(IFLAG,I)                                                000056
      PRINT 801,(CONTOUR(I),I=1,NVC)                                          000057
C                                                                             000058
C        CHECK WHICH GRIDS ARE TO BE PLOTTED AND PROCEED ACCORDINGLY          000059
      DO 101 I=1,5                                                            000060
      IF(IWNTGRD(I).EQ.0) GO TO 10                                            000061
      GO TO (1,2,3,4,5) IWNTGRD(I)                                            000062
C                                                                             000063
C        GRID 5 (GULF OF MAINE)                                               000064
5     DO 51 II=1,22                                                           000065
      DO 51 JJ=1,33                                                           000066
51    Z(II,JJ)=Z5(II,JJ)                                                      000067
      CALL GRID5(I,BASESC)                                                    000068
      CALL NEWPEN(2)                                                          000069
      IF(IFLAG.EQ.2) GO TO 52                                                 000070
      CALL CELLIJ(I,NVC)                                                      000071
      GO TO 101                                                               000072
52    CALL CELL(I,NVC)                                                        000073
      GO TO 101                                                               000074
C                                                                             000075
C        GRID 4 (BAY OF FUNDY)                                                000076
4     DO 41 II=1,25                                                           000077
      DO 41 JJ=1,24                                                           000078
41    Z(II,JJ)=Z4(II,JJ)                                                      000079
      Z(7,25)=Z4(7,24)+(Z4(7,24)-Z4(7,23))                                    000080
      Z(25,24)=2.*Z4(24,24)-Z4(23,24)                                         000081
      M=4                                                                     000082
      DO 43 II=8,23,3                                                         000083
      Z(II,25)=Z5(M,9)                                                        000084
      Z(II+1,25)=Z5(M,9)+(Z5(M+1,9)-Z5(M,9))/3.                               000085
      Z(II+2,25)=Z5(M,9)+(Z5(M+1,9)-Z5(M,9))/1.5                              000086
43    M=M+1                                                                   000087
      CALL NEWPEN(1)                                                          000088
      CALL GRID4(I,BASESC)                                                    000089
      CALL NEWPEN(2)                                                          000090
      IF(IFLAG.EQ.2) GO TO 42                                                 000091
      IF(I.NE.1) GO TO 42                                                     000092
      CALL CELLIJ(I,NVC)                                                      000093
      GO TO 101                                                               000094
42    CALL CELL(I,NVC)                                                        000095
      GO TO 101                                                               000096
C                                                                             000097
C        GRID 3 (CHIGNECTO HEAD)                                              000098
3     DO 31 II=1,25                                                           000099
      DO 31 JJ=1,17                                                           000100
31    Z(II,JJ)=Z3(II,JJ)                                                      000101
      M=63                                                                    000102
      DO 33 II=17,23                                                          000103
       Z(II,1)=(Z3(II+1,3)+Z1(II,M))/2.                                       000104
33    M=M-1                                                                   000105
      CALL NEWPEN(1)                                                          000106
      CALL GRID3(I,BASESC)                                                    000107
      CALL NEWPEN(2)                                                          000108
```

```
      IF(I.NE.1) GO TO 32                                                  000109
      IF(IFLAG.NE.1) GO TO 32                                              000110
      CALL CELLIJ(I,NVC)                                                   000111
      GO TO 101                                                            000112
 32   CALL CELL(I,NVC)                                                     000113
      GO TO 101                                                            000114
C                                                                          000115
C        GRID 2 (CHIGNECTO BAY)                                            000116
 2    DO 21 II=1,15                                                        000117
      DO 21 JJ=1,28                                                        000118
 21   Z(II,JJ)=Z2(II,JJ)                                                   000119
      CALL NEWPEN(1)                                                       000120
      CALL GRID2(I,BASESC)                                                 000121
      CALL NEWPEN(2)                                                       000122
      IF(IFLAG.EQ.2) GO TO 22                                              000123
      IF(I.NE.1) GO TO 22                                                  000124
      CALL CELLIJ(I,NVC)                                                   000125
      GO TO 101                                                            000126
 22   CALL CELL(I,NVC)                                                     000127
      GO TO 101                                                            000128
C                                                                          000129
C        GRID 1 (MINAS BASIN)                                              000130
 1    DO 11 II=1,29                                                        000131
      DO 11 JJ=1,65                                                        000132
 11   Z(II,JJ)=Z1(II,JJ)                                                   000133
      CALL NEWPEN(1)                                                       000134
      CALL GRID1(I,BASESC)                                                 000135
      CALL NEWPEN(2)                                                       000136
      IF(IFLAG.EQ.2) GO TO 12                                              000137
      IF(I.NE.1) GO TO 12                                                  000138
      CALL CELLIJ(I,NVC)                                                   000139
      GO TO 101                                                            000140
 12   CALL CELL(I,NVC)                                                     000141
101   CONTINUE                                                             000142
10    CONTINUE                                                             000143
      PRINT 900,IFLAG                                                      000144
900   FORMAT(* *,*PLOT *,I5,* COMPLETED*)                                  000145
779   CONTINUE                                                             000146
C                                                                          000147
C        LABEL THE PLOT                                                    000148
      CALL PLOT(XUP,YUP,-3)                                                000149
      CALL NEWPEN(1)                                                       000150
      IF(IWHTGRD(1).EQ.3) GO TO 204                                        000151
      HX=27.                                                               000152
      HY=11.5                                                              000153
      GO TO 205                                                            000154
204   HX=10.                                                               000155
      HY=4.                                                                000156
      HXK=HX+6.                                                            000157
      HYK=HY+3.25                                                          000158
      HXM=HX+11.5                                                          000159
      HYM=HY+18.                                                           000160
      HXN=HX+11.                                                           000161
      HYN=HX+3.                                                            000162
      GO TO 201                                                            000163
205   CONTINUE                                                             000164
      HXN=HX+7.75                                                          000165
      HYN=HY+4.                                                            000166
      HXY=HX-2.75                                                          000167
      HXK=HX+5.                                                            000168
      HYK=HY+2.25                                                          000169
      HXSJ=HX+2.                                                           000170
      HYSJ=HY+6.5                                                          000171
      HXSA=HX-2.                                                           000172
      HYSA=HY+8.5                                                          000173
      HXB=HX-23.                                                           000174
      HYB=HY+4.                                                            000175
      HXM=HX+7.75                                                          000176
      HYM=HY+6.75                                                          000177
      CALL SYMBOL(HXY,HY,.14,8HYARMOUTH,0.,8)                              000178
      CALL SYMBOL(HXSA,HYSA,.14,10HST.ANDREWS,0.,10)                       000179
      CALL SYMBOL(HXSJ,HYSJ,.14,8HST. JOHN,0.,8)                           000180
      CALL SYMBOL(HXB,HYB,.14,6HBOSTON,0.,6)                               000181
201   CALL SYMBOL(HXM,HYM,.14,7HMONCTON,0.,7)                              000182
      CALL SYMBOL(HXK,HYK,.14,9HKENTVILLE,0.,9)                            000183
      HXN1=HXN+.689                                                        000184
      HYN1=HYN+1.102                                                       000185
      HYN3=HYN1-.055                                                       000186
      HXN2=HXN1-.118                                                       000187
      HYN2=HYN1-.118                                                       000188
      CALL PLOT(HXN,HYN,3)                                                 000189
      CALL PLOT(HXN1,HYN1,2)                                               000190
      CALL PLOT(HXN2,HYN3,2)                                               000191
      CALL PLOT(HXN1,HYN2,2)                                               000192
      CALL PLOT(HXN1,HYN1,2)                                               000193
      CALL SYMBOL(HXN1,HYN1,.14,1HN,-31.,1)                                000194
816   CONTINUE                                                             000195
      HY1=(HY+2.)                                                          000196
      HX1=(HX+2.8)                                                         000197
      HX2=(HX+5.6)                                                         000198
      HY2=HY+1.                                                            000199
      CALL SYMBOL(HX,HY2,.28,10HAMPLITUDE ,0.,10)                          000200
      CALL SYMBOL(HX1,HY2,.28,10HAND PHASE ,0.,10)                         000201
      CALL SYMBOL(HX2,HY2,.28,5HOF M2,0.,5)                                000202
      READ 802,ALAB                                                        000203
802   FORMAT(A10)                                                          000204
      PRINT 803,ALAB                                                       000205
803   FORMAT(* *,*PLOT IS LABELED  *,A10)                                  000206
      CALL SYMBOL(HX,HY1,.28,ALAB,0.,10)                                   000207
      HX3=(HX+1.)                                                          000208
      HY2=HY                                                               000209
      HY3=HY-1.                                                            000210
      CALL NEWPEN(2)                                                       000211
      CALL PLOT(HX,HY2,3)                                                  000212
      CALL PLOT(HX3,HY2,2)                                                 000213
      CALL NEWPEN(3)                                                       000214
      CALL PLOT(HX,HY3,3)                                                  000215
      CALL PLOT(HX3,HY3,2)                                                 000216
```

```
      CALL NEWPEN(1)                                                    000217
      CALL SYMBOL(HX1,HY2,.28,10HAMPLITUDE ,0.,10)                      000218
      CALL SYMBOL(HX2,HY2,.28,4H(CM),0.,4)                              000219
      CALL SYMBOL(HX1,HY3,.28,10HPHASE (DEG,0.,10)                      000220
      CALL SYMBOL(HX2,HY3,.28,1H),0.,1)                                 000221
      CALL PLOT(0.,0.,999)                                              000222
      STOP                                                              000223
      END                                                               000224
C                                                                       000225
C*************************************************************          000226
C                                                                       000227
      SUBROUTINE GRID5(I,BASESC)                                        000228
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000229
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000230
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                         000231
C                                                                       000232
C        MOVE PEN TO THE ORIGIN OF GRID 5                               000233
      CALL PLOT(33.,22.,-3)                                             000234
      SCALE=BASESC                                                      000235
      IF(IFLAG.EQ.2) GO TO 100                                          000236
      CALL GRDPLOT(I)                                                   000237
100   CONTINUE                                                          000238
C                                                                       000239
C        SET XUP, YUP TO MAINTAIN ORIGIN OF THE PLOT                    000240
      XUP=-33.                                                          000241
      YUP=-22.                                                          000242
      RETURN                                                            000243
      END                                                               000244
C                                                                       000245
C*************************************************************          000246
C                                                                       000247
      SUBROUTINE GRID4(I,BASESC)                                        000248
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000249
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000250
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                         000251
C                                                                       000252
C        CHECK IF GRID 4 IS THE FIRST TO BE PLOTTED                     000253
C        MOVE THE ORIGIN FROM THE PREVIOUS POSITION TO THE              000254
C         ORIGIN FOR GRID 4.                                            000255
      IF(I.EQ.1) GO TO 41                                               000256
      SCALE=BASESC/3.                                                   000257
      X=-9.*BASESC+24.*SCALE                                            000258
      Y=-4.*BASESC+7.*SCALE                                             000259
      GO TO 42                                                          000260
C                                                                       000261
C        SET PEN TO ORIGIN OF GRID 4                                    000262
41    X=24.                                                             000263
      Y=25.                                                             000264
      SCALE=BASESC                                                      000265
42    CALL PLOT(X,Y,-3)                                                 000266
      IF(IFLAG.EQ.2) GO TO 100                                          000267
      CALL GRDPLOT(I)                                                   000268
100   CONTINUE                                                          000269
C                                                                       000270
C        SET XUP,YUP TO MAINTAIN ORIGIN OF PLOT                         000271
      XUP=XUP-X                                                         000272
      YUP=YUP-Y                                                         000273
      RETURN                                                            000274
      END                                                               000275
C                                                                       000276
C*************************************************************          000277
C                                                                       000278
      SUBROUTINE GRID3(I,BASESC)                                        000279
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000280
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000281
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                         000282
C                                                                       000283
C        CHECK IF GRID 3 IS THE FIRST TO BE PLOTTED                     000284
      IF(I.EQ.1) GO TO 31                                               000285
      SCALE=BASESC/9.                                                   000286
      IF(IWNTGRD(1).EQ.4) SCALE=SCALE*3.                                000287
C                                                                       000288
CC       SET PEN TO ORIGIN OF GRID 3                                    000289
      X=-2.*SCALE*3.+17.*SCALE                                          000290
      Y=-9.*SCALE*3.+2.*SCALE                                           000291
      GO TO 34                                                          000292
C                                                                       000293
C        IF GRID 3 IS THE FIRST WE MUST CHECK HOW MANY GRIDS ARE TO     000294
C         FOLLOW IN ORDER TO SCALE THE PLOTS CORRECTLY TO FIT ON ONE    000295
C         PLOT                                                          000296
31    IF(IWNTGRD(I+1).EQ.2.AND.IWNTGRD(I+2).EQ.1) GO TO 33              000297
      IF(IWNTGRD(I+1).EQ.1) GO TO 33                                    000298
C                                                                       000299
C        ADJUST SCALE SO THE WHOLE PLOT FITS                            000300
      SCALE=BASESC*.8                                                   000301
      GO TO 35                                                          000302
33    SCALE=BASESC*.4                                                   000303
35    X=17.                                                             000304
      Y=20.                                                             000305
34    CALL PLOT(X,Y,-3)                                                 000306
      IF(IFLAG.EQ.2) GO TO 100                                          000307
      CALL GRDPLOT(I)                                                   000308
100   CONTINUE                                                          000309
C                                                                       000310
C        SET XUP,YUP TO MAINTAIN ORIGIN OF THE PLOT                     000311
      XUP=XUP-X                                                         000312
      YUP=YUP-Y                                                         000313
      RETURN                                                            000314
      END                                                               000315
C                                                                       000316
C*************************************************************          000317
C                                                                       000318
      SUBROUTINE GRID2(I,BASESC)                                        000319
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000320
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000321
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                         000322
C                                                                       000323
C        CHECK IF GRID 2 IS THE FIRST TO BE PLOTTED                     000324
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      IF(I.EQ.1) GO TO 21                                                   000325
C                                                                           000326
C        SET THE SCALES CORRECTLY ON THE PLOTS                              000327
      GO TO (~2,23,24) (IWNTGRD(1)-2)                                       000328
24    SCALE=BASESC/9.                                                       000329
      GO TO 26                                                              000330
23    SCALE=BASESC/3.                                                       000331
      GO TO 26                                                              000332
C                                                                           000333
C        CHECK IF GRID 1 IS TO BE PLOTTED                                   000334
22    IF(IWNTGRD(I+1).EQ.1) GO TO 25                                        000335
      SCALE=BASESC*.8                                                       000336
      GO TO 26                                                              000337
25    SCALE=BASESC*.4                                                       000338
26    X=(-2.+27.)*SCALE                                                     000339
      Y=(-3.+8.)*SCALE                                                      000340
      GO TO 27                                                              000341
21    X=27.                                                                 000342
      Y=15.                                                                 000343
      SCALE=BASESC                                                          000344
27    CALL PLOT(X,Y,-3)                                                     000345
      IF(IFLAG.EQ.2) GO TO 100                                              000346
      CALL GRDPLOT(I)                                                       000347
100   CONTINUE                                                              000348
C                                                                           000349
C        SET XUP,YUP TO MAINTAIN ORIGIN OF THE PLOT                         000350
      XUP=XUP-X                                                             000351
      YUP=YUP-Y                                                             000352
      RETURN                                                                000353
      END                                                                   000354
C                                                                           000355
C*************************************************************            000356
C                                                                           000357
      SUBROUTINE GRID1(I,BASESC)                                            000358
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                       000359
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                               000360
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                             000361
      ROOT2=SQRT(2.)                                                        000362
C                                                                           000363
C        CHECK IF GRID 1 IS THE ONLY ONE TO BE PLOTTED                      000364
      IF(I.EQ.1) GO TO 11                                                   000365
C                                                                           000366
C        SET SCALES FOR THE PLOT                                            000367
      GO TO (12,12,13,14) (IWNTGRD(1)-1)                                    000368
14    SCALE=(BASESC/9.)/ROOT2                                               000369
      GO TO 15                                                              000370
13    SCALE=(BASESC/3.)/ROOT2                                               000371
      GO TO 15                                                              000372
12    SCALE=(BASESC/ROOT2)*.8                                               000373
15    IF(IWNTGRD(I-1).EQ.2) GO TO 16                                        000374
      X=-3.*SCALE*ROOT2+(18.+65.)*SCALE/ROOT2                               000375
      Y=-18.*SCALE*ROOT2+(18.-65.)*SCALE/ROOT2                              000376
      GO TO 17                                                              000377
16    X=-28.*SCALE*ROOT2+(18.+65.)*SCALE/ROOT2                              000378
      Y=-23.*SCALE*ROOT2+(18.-65.)*SCALE/ROOT2                              000379
      GO TO 17                                                              000380
11    SCALE=BASESC/ROOT2                                                    000381
      Y=29.*SCALE                                                           000382
      X=65.*SCALE                                                           000383
17    CALL PLOT(X,Y,-3)                                                     000384
      IF(IFLAG.EQ.2) GO TO 100                                              000385
      CALL GRDPLOT(I)                                                       000386
100   CONTINUE                                                              000387
C                                                                           000388
C        SET XUP,YUP TO MAINTAIN THE ORIGIN OF THE PLOT                     000389
      XUP=XUP-X                                                             000390
      YUP=YUP-Y                                                             000391
      RETURN                                                                000392
      END                                                                   000393
C                                                                           000394
C*************************************************************            000395
C                                                                           000396
      SUBROUTINE GRDPLOT(K)                                                 000397
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                       000398
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                               000399
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                             000400
C                                                                           000401
C        SUBROUTINE TO PLOT THE DESIRED GRID                                000402
C        PEN INSTRUCTIONS ARE INCLUDED IN IGRD                              000403
      J=NPTS(IWNTGRD(K))                                                    000404
      DO 120 I=1,J                                                          000405
      IP=2                                                                  000406
      XX=-FLOAT(IGRD(3,I,IWNTGRD(K)))*SCALE                                 000407
      YY=-FLOAT(IGRD(2,I,IWNTGRD(K)))*SCALE                                 000408
      IF(IWNTGRD(K).NE.1) GO TO 20                                          000409
      CALL ROTATE(XX,YY,X,Y,K)                                              000410
      XX=-XX                                                                000411
20    IPEN=IGRD(1,I,IWNTGRD(K))                                             000412
      IF(IPEN.EQ.2) IP=3                                                    000413
120   CALL PLOT(XX,YY,IP)                                                   000414
      RETURN                                                                000415
      END                                                                   000416
C                                                                           000417
C*************************************************************            000418
C                                                                           000419
      SUBROUTINE TRACK(CNTR,I,J,JEND,KGRD)                                  000420
C                                                                           000421
C       SUBROUTINE TO CALCULATE AND PLOT THE CONTOURS IN CELL I,J           000422
      DIMENSION ISET(4),EX(4),EY(4)                                         000423
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                       000424
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                               000425
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                             000426
      X=FLOAT(I)+.5                                                         000427
      Y=FLOAT(J)+.5                                                         000428
C                                                                           000429
C       INITIALIZE ISET                                                     000430
      DO 100 K=1,4                                                          000431
      EX(K)=X                                                               000432
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      EY(K)=Y                                                           000433
      ISET(K)=0                                                         000434
100   DIST2=10.                                                         000435
      DIST3=10.                                                         000436
      DIST4=10.                                                         000437
      ZE1=Z(I,J)                                                        000438
      ZE2=Z(I+1,J)                                                      000439
      ZE3=Z(I+1,J+1)                                                    000440
      ZE4=Z(I,J+1)                                                      000441
      IF(IFLAG.EQ.1) GO TO 806                                          000442
C                                                                       000443
C       MAKE ADJUSTMENTS FOR THE CYCLIC NATURE OF THE PHASE             000444
      IF(IB(1).EQ.4.OR.IB(2).EQ.4) GO TO 800                            000445
      D1=ABS(ZE1-ZE2)                                                   000446
      IF(D1.LE.(360.-D1)) GO TO 800                                     000447
      IF(ZE1.GE.ZE2) GO TO 801                                          000448
      ZE1=ZE1+360.                                                      000449
      GO TO 800                                                         000450
801   ZE2=ZE2+360.                                                      000451
800   D1=ABS(ZE2-ZE3)                                                   000452
      IF(IB(2).EQ.4.OR.IB(3).EQ.4) GO TO 802                            000453
      IF(D1.LE.(360.-D1)) GO TO 802                                     000454
      IF(ZE2.GE.ZE3) GO TO 803                                          000455
      ZE2=ZE2+360.                                                      000456
      GO TO 802                                                         000457
803   ZE3=ZE3+360.                                                      000458
802   D1=ABS(ZE3-ZE4)                                                   000459
      IF(IB(3).EQ.4.OR.IB(4).EQ.4) GO TO 804                            000460
      IF(D1.LE.(360.-D1)) GO TO 804                                     000461
      IF(ZE3.GE.ZE4) GO TO 805                                          000462
      ZE3=ZE3+360.                                                      000463
      GO TO 804                                                         000464
805   ZE4=ZE4+360.                                                      000465
804   D1=ABS(ZE4-ZE1)                                                   000466
      IF(IB(1).EQ.4.OR.IB(4).EQ.4) GO TO 806                            000467
      IF(D1.LE.(360.-D1)) GO TO 806                                     000468
      IF(ZE4.GE.ZE1) GO TO 807                                          000469
      ZE4=ZE4+360.                                                      000470
      GO TO 806                                                         000471
807   ZE1=ZE1+360.                                                      000472
806   CONTINUE                                                          000473
C                                                                       000474
C       FIND THE LOCATIONS OF CNTR ON EACH SIDE. SIDES ARE CODED        000475
C      1=TOP, 2=RIGHT, 3=BOTTOM, 4=LEFT                                 000476
C         DO SIDE 1 FIRST                                               000477
C       IF IB1=4 THERE ARE NO INTERSECTIONS( ABBREVIATED NTRX) ON       000478
C          SIDES 1 OR 4                                                 000479
      IF(IB(1).NE.4) GO TO 1                                            000480
      ISET(4)=1                                                         000481
      GO TO 2                                                           000482
C                                                                       000483
C       CHECK IF IB2=4                                                  000484
1     IF(IB(2).EQ.4) GO TO 2                                            000485
C                                                                       000486
C      DETERMINE IF THERE IS AN NTRX                                    000487
      D1=ZE1-CNTR                                                       000488
      D2=ZE2-CNTR                                                       000489
      IF(D1.GE.0..AND.D2.LE.0.) GO TO 3                                 000490
      IF(D2.GE.0..AND.D1.LE.0.) GO TO 4                                 000491
C                                                                       000492
C      NO NTRX ON SIDE 1 GO ON TO SIDE 2                                000493
2     ISET(1)=1                                                         000494
      GO TO 6                                                           000495
C                                                                       000496
C      DETERMINE X,Y OF NTRX                                            000497
3     EX(1)=X+D1/(ZE1-ZE2)                                              000498
      GO TO 5                                                           000499
4     EX(1)=X+1.-D2/(ZE2-ZE1)                                           000500
5     EY(1)=Y                                                           000501
6     CONTINUE                                                          000502
C                                                                       000503
C      SIDE 2                                                           000504
C      IF IB2=4 NO NTRX ON SIDES 1 OR 2. SIDE 1 HAS ALREADY             000505
C       BEEN ACCOUNTED FOR.                                             000506
      IF(IB(2).EQ.4) GO TO 7                                            000507
C                                                                       000508
C      CHECK IF IB3=4                                                   000509
      IF(IB(3).NE.4) GO TO 8                                            000510
      ISET(3)=1                                                         000511
      GO TO 7                                                           000512
C                                                                       000513
C      DETERMINE IF THERE IS AN NTRX                                    000514
8     D1=ZE2-CNTR                                                       000515
      D2=ZE3-CNTR                                                       000516
      IF(D1.GE.0..AND.D2.LE.0.) GO TO 9                                 000517
      IF(D2.GE.0..AND.D1.LE.0.) GO TO 10                                000518
C                                                                       000519
C      NO NTRX ON SIDE 2, GO ON TO SIDE 3                               000520
7      ISET(2)=1                                                        000521
      GO TO 12                                                          000522
C                                                                       000523
C       DETERMINE X,Y OF NTRX                                           000524
9     EY(2)=Y+D1/(ZE2-ZE3)                                              000525
      GO TO 11                                                          000526
10    EY(2)=Y+1.-D2/(ZE3-ZE2)                                           000527
11    EX(2)=X+1.                                                        000528
12    CONTINUE                                                          000529
C                                                                       000530
C      SIDE 3                                                           000531
C      IF IB3=4 NO NTRX ON SIDES 2 OR 3. SIDE 2 HAS ALREADY             000532
C      BEEN ACCOUNTED FOR                                               000533
      IF(IB(3).EQ.4) GO TO 13                                           000534
C                                                                       000535
C      CHECK IF IB4=4                                                   000536
      IF(IB(4).NE.4) GO TO 14                                           000537
      ISET(4)=1                                                         000538
      GO TO 13                                                          000539
C                                                                       000540
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C       DETERMINE IF THERE IS AN NTRX                                   000541
14      D1=ZE4-CNTR                                                     000542
        D2=ZE3-CNTR                                                     000543
        IF(D1.GE.0..AND.D2.LE.0.) GO TO 15                              000544
        IF(D2.GE.0..AND.D1.LE.0.) GO TO 16                              000545
C                                                                       000546
C       NO NTRX ON SIDE 3. GO ON TO SIDE 4                              000547
13      ISET(3)=1                                                       000548
        GO TO 18                                                        000549
C                                                                       000550
C       DETERMINE X,Y OF NTRX                                           000551
15      EX(3)=X+D1/(ZE4-ZE3)                                            000552
        GO TO 17                                                        000553
16      EX(3)=X+1.-D2/(ZE3-ZE4)                                         000554
17      EY(3)=Y+1.                                                      000555
18      CONTINUE                                                        000556
C                                                                       000557
C       SIDE 4                                                          000558
C       IF IB4=4 NO NTRX ON SIDES 3 OR 4. SIDE 3 HAS ALREADY            000559
C       BEEN ACCOUNTED FOR.                                             000560
        IF(IB(4).EQ.4) GO TO 19                                         000561
        IF(IB(1).EQ.4) GO TO 19                                         000562
C                                                                       000563
C       IB1 NEED NOT BE CHECKED, IT WAS DONE PREVIOUSLY                 000564
        D1=ZE1-CNTR                                                     000565
        D2=ZE4-CNTR                                                     000566
        IF(D1.GE.0..AND.D2.LE.0.) GO TO 20                              000567
        IF(D2.GE.0..AND.D1.LE.0.) GO TO 21                              000568
C                                                                       000569
C       NO NTRX ON SIDE 4                                               000570
19      ISET(4) =1                                                      000571
        GO TO 23                                                        000572
C                                                                       000573
C       DETERMINE X,Y OF NTRX                                           000574
20      EY(4)=Y+D1/(ZE1-ZE4)                                            000575
        GO TO 22                                                        000576
21      EY(4)=Y+1.-D2/(ZE4-ZE1)                                         000577
22      EX(4)=X                                                         000578
23      CONTINUE                                                        000579
C                                                                       000580
C       IT IS NOW DETERMINED IF NTRX ON THE DIFFERENT SIDES             000581
C       MAY BE JOINED. THIS DEPENDS ON IF THERE ARE SHORELINES          000582
C       PRESENT. SIDE 1 IS FIRST CHECKED FOR AN NTRX. IF IT             000583
C       HAS ONE THE OTHER 3 SIDES ARE CHECKED.                          000584
        IF(ISET(1).EQ.1) GO TO 150                                      000585
C                                                                       000586
C       SIDE 1 HAS AN NTRX. DOES SIDE 2                                 000587
        IF(ISET(2).EQ.1) GO TO 50                                       000588
C                                                                       000589
C       SIDE 2 HAS AN NTRX. IS THE CONTOUR A DIAGONAL                   000590
        IF(EX(1).NE.X.OR.EY(2).NE.(Y+1.)) GO TO 51                      000591
C                                                                       000592
C       IF IB3=3 OR 4 NO DIAGONAL IS ALLOWED                            000593
        IF(IB(3).EQ.3.OR.IB(3).EQ.4) GO TO 52                           000594
C                                                                       000595
C       IF IB3=1 AND IB4=1,3 OR 4 NO DIAGONAL IS ALLOWED                000596
        IF(IB(3).NE.1) GO TO 49                                         000597
        IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 52                          000598
49      DIST2=SQRT(2.)                                                  000599
        GO TO 50                                                        000600
C                                                                       000601
C       THERE IS NO DIAGONAL CONTOUR. FIND WHERE NTRX1 AND              000602
C       NTRX2 OCCUR ON SIDES 1 AND 2                                    000603
51      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 50                           000604
        IF(IB(3).EQ.1.OR.IB(3).EQ.3) GO TO 50                           000605
        D1=EX(1)-(X+.5)                                                 000606
        D2=EY(2)-(Y+.5)                                                 000607
        IF(D1.LT.0.) GO TO 48                                           000608
        IF(D2.GT.0.) GO TO 54                                           000609
C                                                                       000610
C       CONTOUR FROM RIGHT1 TO TOP2                                     000611
48      DIST2=(EX(1)-EX(2))**2+(EY(1)-EY(2))**2                         000612
        GO TO 50                                                        000613
C                                                                       000614
C       CONTOUR FROM RIGHT1 TO BOTTOM2                                  000615
54      IF(IB(3).NE.4) GO TO 48                                         000616
        GO TO 52                                                        000617
C                                                                       000618
C       CONTOUR FROM LEFT1 TO BOTTOM2                                   000619
52      DIST2=10.                                                       000620
50      CONTINUE                                                        000621
C                                                                       000622
C       SIDE 1 HAS AN NTRX. DOES SIDE 3                                 000623
        IF(ISET(3).EQ.1) GO TO 55                                       000624
C                                                                       000625
C       SIDE 3 HAS AN NTRX. IS THE CONTOUR A DIAGONAL                   000626
        IF(EX(1).NE.X.OR.EX(3).NE.(X+1.)) GO TO 56                      000627
C                                                                       000628
C       DIAGONAL IS TOP LEFT TO BOTTOM RIGHT                            000629
        IF(IB(3).EQ.3) GO TO 57                                         000630
        IF(IB(3).EQ.0) GO TO 59                                         000631
        IF(IB(3).EQ.1) GO TO 58                                         000632
        IF(IB(2).NE.0.AND.IB(2).NE.1) GO TO 57                          000633
59      DIST3=SQRT(2.)                                                  000634
        GO TO 55                                                        000635
58      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000636
        GO TO 59                                                        000637
C                                                                       000638
C       CHECK IF IT IS THE OTHER DIAGONAL                               000639
56      IF(EX(1).NE.(X+1.).OR.EX(3).NE.X) GO TO 60                      000640
C                                                                       000641
C       DIAGONAL IS TOP RIGHT TO BOTTOM LEFT                            000642
        IF(IB(3).EQ.0) GO TO 59                                         000643
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 57                           000644
        IF(IB(4).EQ.0.OR.IB(4).EQ.2) GO TO 59                           000645
        GO TO 57                                                        000646
C                                                                       000647
C       CONTOUR IS NOT A DIAGONAL. FIND OUT WHERE ON                    000648
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C       SIDE 1 AND SIDE 3 THE NTRX ARE                                  000649
60      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 55                           000650
        IF(IB(3).EQ.2.OR.IB(3).EQ.3) GO TO 55                           000651
        D1=EX(1)-(X+.5)                                                 000652
        D3=EX(3)-(X+.5)                                                 000653
        IF(D1) 61,62,63                                                 000654
63      IF(D3.LT.0.) GO TO 45                                           000655
C                                                                       000656
C       RIGHT1 TO RIGHT3                                                000657
39      IF(IB(3).NE.0) GO TO 57                                         000658
46      DIST3=(EX(1)-EX(3))**2+(EY(1)-EY(3))**2                         000659
        GO TO 55                                                        000660
C                                                                       000661
C       RIGHT1 TO LEFT3. WHAT SIDE OF THE CENTRE POINT DOES             000662
C         THE CONTOUR LIE.                                              000663
45      DD1=X+1.-EX(1)                                                  000664
        DD3=EX(3)-X                                                     000665
        IF(IB(2).EQ.4.OR.IB(4).EQ.4) GO TO 57                           000666
        IF(DD1-DD3) 44,43,42                                            000667
C                                                                       000668
C       RIGHT OF MIDDLE                                                 000669
44      IF(IB(3).NE.0) GO TO 57                                         000670
        GO TO 46                                                        000671
C                                                                       000672
C       THROUGH THE MIDDLE                                              000673
43      IF(IB(3).EQ.0) GO TO 46                                         000674
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 57                           000675
        GO TO 46                                                        000676
C                                                                       000677
C       LEFT OF MIDDLE                                                  000678
42      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000679
        GO TO 46                                                        000680
C                                                                       000681
C       NTRX IN MIDDLE OF SIDE 1                                        000682
62      IF(D3.NE.0.) GO TO 40                                           000683
        IF(IB(3).NE.1) GO TO 46                                         000684
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 57                           000685
        GO TO 46                                                        000686
40      IF(D3.GT.0.) GO TO 39                                           000687
        GO TO 37                                                        000688
C                                                                       000689
C       NTRX ON LEFT HALF OF SIDE 1                                     000690
61      IF(D3.GT.0.) GO TO 38                                           000691
37      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000692
        GO TO 46                                                        000693
C                                                                       )00694
C       LEFT1 TO RIGHT3. WHAT SIDE OF THE CENTRE POINT                  000695
C         DOES THE CONTOUR LIE.                                         000696
38      DD1=EX(1)-X                                                     000697
        DD3=X+1.-EX(3)                                                  000698
        IF(DD1-DD3) 36,33,34                                            000699
C                                                                       000700
C       LEFT OF MIDDLE                                                  000701
36      IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000702
        GO TO 46                                                        000703
C                                                                       000704
C          THROUGH THE MIDDLE                                           000705
33      IF(IB(3).NE.1) GO TO 46                                         000706
        IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 57                          000707
        GO TO 46                                                        000708
C                                                                       000709
C       RIGHT OF MIDDLE                                                 000710
34      IF(IB(3).NE.0) GO TO 57                                         000711
        IF(IB(2).EQ.0.OR.IB(2).EQ.1) GO TO 46                           000712
57      DIST3=10.                                                       000713
55      CONTINUE                                                        000714
C                                                                       000715
C       SIDE 1 HAS AN NTRX. DOES SIDE 4,                                000716
        IF(ISET(4).EQ.1) GO TO 66                                       000717
C                                                                       000718
C       CHECK IF THE CONTOUR IS A DIAGONAL                              000719
        IF(EX(1).NE.(X+1).OR.EY(4).NE.(Y+1.)) GO TO 64                  000720
C                                                                       000721
C         IS THE DIAGONAL ALLOWED.                                      000722
        IF(IB(3).EQ.0) GO TO 300                                        000723
        IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 65                           000724
        IF(IB(4).NE.0.AND.IB(4).NE.2) GO TO 65                          000725
300     DIST4=SQRT(2.)                                                  000726
        GO TO 66                                                        000727
C                                                                       000728
C       NO DIAGONAL. FIND OUT WHERE THE NTRX ARE ON SIDES               000729
C         1 AND 4                                                       000730
64      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 66                           000731
        IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 66                           000732
        D1=EX(1)-(X+.5)                                                 000733
        D2=EY(4)-(Y+.5)                                                 000734
        IF(D1.GT.0.) GO TO 68                                           000735
C                                                                       000736
C       NTRX ON LEFT HALF OF SIDE 1                                     000737
        GO TO 68                                                        000738
C                                                                       000739
C       RIGHT HALF OF SIDE 1, BOTTOM HALF OF SIDE 4                     000740
68      DIST4=(EX(1) EX(4))**2+(EY(1)-EY(4))**2                         000741
        GO TO 66                                                        000742
65      DIST4=10.                                                       000743
66      CONTINUE                                                        000744
C                                                                       000745
C       NOW FIND THE CLOSEST NTRX                                       000746
        IF(DIST2-DIST3) 70,72,72                                        000747
72      IF(DIST3-DIST4) 74,73,73                                        030748
70      IF(DIST2-DIST4) 75,73,73                                        000749
73      XX=EX(4)*SCALE                                                  000750
        YY=EY(4)*SCALE                                                  000751
        X1=EX(2)*SCALE                                                  000752
        Y1=EY(2)*SCALE                                                  000753
        X2=EX(3)*SCALE                                                  000754
        Y2=EY(3)*SCALE                                                  000755
        IF((DIST2+DIST3+DIST4).GE.30.) GO TO 250                        000756
```

```
      GO TO 80                                                          000757
74    XX=EX(3)*SCALE                                                    000758
      YY=EY(3)*SCALE                                                    000759
      X1=EX(2)*SCALE                                                    000760
      Y1=EY(2)*SCALE                                                    000761
      X2=EX(4)*SCALE                                                    000762
      Y2=EY(4)*SCALE                                                    000763
      GO TO 80                                                          000764
75    XX=EX(2)*SCALE                                                    000765
      YY=EY(2)*SCALE                                                    000766
      X1=EX(3)*SCALE                                                    000767
      Y1=EY(3)*SCALE                                                    000768
      X2=EX(4)*SCALE                                                    000769
      Y2=EY(4)*SCALE                                                    000770
80    X=EX(1)*SCALE                                                     000771
      Y=EY(1)*SCALE                                                     000772
      IF((DIST2+DIST3+DIST4).GE.30.) GO TO 250                          000773
      CALL ROTATE(XX,YY,X,Y,KGRD)                                       000774
      IF(IFLAG.EQ.1) GO TO 301                                          000775
      CALL NEWPEN(3)                                                    000776
301   CALL PLOT(X,Y,3)                                                  000777
      CALL PLOT(XX,YY,2)                                                000778
C                                                                       000779
C      CHECK IF THERE ARE 4 GOOD NTRX IN THIS BOX. IF SO JOIN           000780
C       THE 2 CLOSEST THEN JOIN THE OTHER 2.                            000781
      IF(DIST2.GE.10..OR.DIST3.GE.10..OR.DIST4.GE.10.) GO TO 249        000782
      CALL ROTATE(X1,Y1,X2,Y2,KGRD)                                     000783
      CALL PLOT(X1,Y1,3)                                                000784
      CALL PLOT(X2,Y2,2)                                                000785
      GO TO 249                                                         000786
C                                                                       000787
C      SIDE 1 HAS NO NTRX. DOES SIDE 2.                                 000788
150   IF(ISET(2).EQ.1) GO TO 200                                        000789
C                                                                       000790
C      SIDE 2 HAS AN NTRX. DOES SIDE 3.                                 000791
      IF(ISET(3).EQ.1) GO TO 90                                         000792
C                                                                       000793
C      IS THE CONTOUR A DIAGONAL.                                       000794
      IF(EY(2).NE.Y.OR.EX(3).NE.X) GO TO 91                             000795
C                                                                       000796
C      CONTOUR IS A DIAGONAL.                                           000797
      IF(IB(3).EQ.0) GO TO 88                                           000798
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 92                             000799
      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 92                             000800
88    DIST3=SQRT(2.)                                                    000801
      GO TO 90                                                          000802
C                                                                       000803
C      CONTOUR IS NOT A DIAGONAL. FIND OUT WHERE THE NTRX               000804
C       IS ON SIDE 2 AND SIDE 3.                                        000805
91    IF(IB(3).NE.0) GO TO 90                                           000806
      D2=EY(2)-(Y+.5)                                                   000807
      D3=EX(3)-(X+.5)                                                   000808
      IF(D2.LT.0.) GO TO 93                                             000809
C                                                                       000810
C      NTRX IS ON THE BOTTOM HALF OF SIDE 2                             000811
      IF(IB(3).NE.0) GO TO 92                                           000812
96    DIST3=(EX(2)-EX(3))**2+(EY(2)-EY(3))**2                           000813
      GO TO 90                                                          000814
C                                                                       000815
C      NTRX IS ON THE TOP HALF OF SIDE 2                                000816
93    IF(D3.LT.0.) GO TO 94                                             000817
C                                                                       000818
C      NTRX IS ON THE RIGHT HALF OF SIDE 3                              000819
      IF(IB(3).EQ.0) GO TO 96                                           000820
      GO TO 92                                                          000821
C                                                                       000822
C      NTRX IS ON THE LEFT HALF OF SIDE 3                               000823
94    IF(IB(3).EQ.0) GO TO 96                                           000824
92    DIST3=10.                                                         000825
90    CONTINUE                                                          000826
C                                                                       000827
C      SIDE 2 HAS AN NTRX. DOES SIDE 4.                                 000828
      IF(ISET(4).EQ.1) GO TO 120                                        000829
C                                                                       000830
C      IS THE CONTOUR A DIAGONAL.                                       000831
      IF(EY(2).EQ.Y.AND.EY(4).EQ.(Y+1)) GO TO 105                       000832
      IF(EY(2).NE.(Y+1).OR.EY(4).NE.Y) GO TO 106                        000833
C                                                                       000834
C      DIAGONAL IS TOP LEFT TO BOTTOM RIGHT                             000835
      IF(IB(3).EQ.3) GO TO 107                                          000836
      IF(IB(3).EQ.2.AND.IB(2).EQ.2) GO TO 107                           000837
      IF(IB(3).EQ.2.AND.IB(2).EQ.3) GO TO 107                           000838
      IF(IB(3).EQ.0) GO TO 89                                           000839
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 107                            000840
89    IF(IB(2).NE.2.AND.IB(3).NE.3) GO TO 109                           000841
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 107                            000842
109   DIST4=SQRT(2.)                                                    000843
      GO TO 120                                                         000844
C                                                                       000845
C      DIAGONAL IS TOP RIGHT TO BOTTOM LEFT                             000846
105   IF(IB(3).EQ.0) GO TO 109                                          000847
      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                            000848
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 107                            000849
      GO TO 109                                                         000850
C                                                                       000851
C      CONTOUR IS NOT A DIAGONAL. FIND OUT WHERE ON SIDES               000852
C       2 AND 4 THE NTRX ARE.                                           000853
106   IF(IB(3).EQ.1.OR.IB(3).EQ.3) GO TO 120                            000854
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 120                            000855
      D2=EY(2)-(Y+.5)                                                   000856
      D4=EY(4)-(Y+.5)                                                   000857
      IF(D2.GT.0.) GO TO 110                                            000858
C                                                                       000859
C      NTRX IS ON THE TOP HALF OF SIDE 2                                000860
      IF(D4.GT.0.) GO TO 111                                            000861
C                                                                       000862
C      NTRX IS ON THE TOP HALF OF SIDE 4                                000863
      IF(D2.NE.0..AND.D4.NE.0.) GO TO 112                               000864
```

```
C                                                                       000865
      IF(IB(3).EQ.2.AND.IB(2).EQ.2) GO TO 107                           000866
      IF(IB(2).EQ.1.OR.IB(2).EQ.0) GO TO 114                            000867
      GO TO 114                                                         000868
112   IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                            000869
114   DIST4=(EX(2)-EX(4))**2+(EY(2)-EY(4))**2                           000870
      GO TO 120                                                         000871
C                                                                       000872
C      CONTOUR RUNS FROM TOP2 TO BOTTOM4                                000873
111   DD2=EY(2)-Y                                                       000874
      DD4=Y+1.-EY(4)                                                    000875
      IF((DD4-DD2).GE.0.) GO TO 113                                     000876
C                                                                       000877
C      CONTOUR RUNS BELOW MIDDLE OF CELL                                000878
      IF(IB(3).NE.0) GO TO 107                                          000879
      GO TO 114                                                         000880
C                                                                       000881
C      CONTOUR RUNS THROUGH OR ABOVE MIDDLE                             000882
113   IF(DD4.NE.DD2) GO TO 115                                          000883
C                                                                       000884
C      CONTOUR RUNS THROUGH THE MIDDLE                                  000885
      IF(IB(3).EQ.0) GO TO 114                                          000886
      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                            000887
      GO TO 114                                                         000888
C                                                                       000889
C      CONTOUR RUNS ABOVE MIDDLE                                        000890
115   IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 107                            000891
      GO TO 114                                                         000892
C                                                                       000893
C      NTRX IS ON THE BOTTOM HALF OF SIDE 2                             000894
110   IF(D4.LT.0.) GO TO 117                                            000895
C                                                                       000896
C      CONTOUR IS ON THE BOTTOM HALF OF SIDE 4                          000897
      GO TO 114                                                         000898
C                                                                       000899
C      CONTOUR RUNS FROM  BOTTOM2 TO TOP4                               000900
117   DD4=EY(4)-Y                                                       000901
      DD2=Y+1.-EY(2)                                                    000902
      IF((DD4-DD2).LE.0.) GO TO 118                                     000903
C                                                                       000904
C      CONTOUR RUNS BELOW MIDDLE OF CELL                                000905
      IF(IB(3).EQ.2) GO TO 107                                          000906
      GO TO 114                                                         000907
C                                                                       000908
C      CONTOUR RUNS THROUGH OR ABOVE MIDDLE                             000909
118   IF(DD2.NE.DD4) GO TO 119                                          000910
C                                                                       000911
C      CONTOUR RUNS THROUGH MIDDLE OF CELL                              000912
      IF(IB(2).NE.2.AND.IB(2).NE.3) GO TO 114                           000913
      IF(IB(3).EQ.2) GO TO 107                                          000914
      GO TO 114                                                         000915
C                                                                       000916
C      CONTOUR RUNS ABOVE MIDDLE                                        000917
119   IF(IB(2).NE.2.AND.IB(2).NE.3) GO TO 114                           000918
107   DIST4=10.                                                         000919
120   CONTINUE                                                          000920
C                                                                       000921
C      DETERMINE THE CLOSEST NTRX                                       000922
      IF(DIST3.GE.DIST4) GO TO 121                                      000923
      XX=EX(3)*SCALE                                                    000924
      YY=EY(3)*SCALE                                                    000925
      GO TO 122                                                         000926
121   XX=EX(4)*SCALE                                                    000927
      YY=EY(4)*SCALE                                                    000928
122   X=EX(2)*SCALE                                                     000929
      Y=EY(2)*SCALE                                                     000930
      IF((DIST3+DIST4).GE.20.) GO TO 250                                000931
      CALL ROTATE(XX,YY,X,Y,KGRD)                                       000932
      IF(IFLAG.EQ.1) GO TO 303                                          000933
      CALL NEWPEN(3)                                                    000934
303   CALL PLOT(XX,YY,3)                                                000935
      CALL PLOT(X,Y,2)                                                  000936
      GO TO 249                                                         000937
C                                                                       000938
C      SIDE 2 HAS NO NTRX. DOES SIDE 3.                                 000939
200   IF(ISET(3).EQ.1) GO TO 250                                        000940
C                                                                       000941
C      SIDE 3 HAS AN NTRX. DOES SIDE 4.                                 000942
      IF(ISET(4).EQ.1) GO TO 250                                        000943
C                                                                       000944
C      IS THE CONTOUR A DIAGONAL.                                       000945
      IF(EY(4).NE.Y.OR.EX(3).NE.(X+1.)) GO TO 130                       000946
      IF(IB(3).EQ.3) GO TO 250                                          000947
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 131                            000948
      IF(IB(3).NE.0.AND.IB(3).NE.1) GO TO 132                           000949
133   DIST4=SQRT(2.)                                                   000950
      GO TO 249                                                         000951
132   IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 250                            000952
      GO TO 133                                                         000953
131   IF(IB(3).EQ.1.OR.IB(3).EQ.3) GO TO 250                            000954
      IF(IB(2).EQ.2.OR.IB(2).EQ.3) GO TO 250                            000955
      GO TO 133                                                         000956
C                                                                       000957
C      CONTOUR IS NOT A DIAGONAL. FIND WHERE ON SIDES                   000958
C      3 AND 4 THE NTRX ARE.                                            000959
130   IF(IB(3).EQ.2.OR.IB(3).EQ.3) GO TO 250                            000960
      IF(IB(4).EQ.1.OR.IB(4).EQ.3) GO TO 250                            000961
135   X=EX(3)*SCALE                                                     000962
      Y=EY(3)*SCALE                                                     000963
      XX=EX(4)*SCALE                                                    000964
      YY=EY(4)*SCALE                                                    000965
      CALL ROTATE(XX,YY,X,Y,KGRD)                                       000966
      IF(IFLAG.EQ.1) GO TO 302                                          000967
      CALL NEWPEN(3)                                                    000968
302   CALL PLOT(XX,YY,3)                                                000969
      CALL PLOT(X,Y,2)                                                  000970
C                                                                       000971
C      LABEL THE PLOTS                                                  000972
```

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249   IF(IFLAG.EQ.2) GO TO 900                                          000973
      IF(IWNTGRD(KGRD).EQ.1) GO TO 250                                  000974
900   IF(I.NE.1.AND.I.NE.JEND) GO TO 248                                000975
C                                                                       000976
C      CONTOUR IS ON AN EDGE                                            000977
      CALL NUMBER(XX,YY,.28,CNTR,0.,-1)                                 000978
      GO TO 250                                                         000979
C                                                                       000980
C     CONTOUR IS IN THE INTERIOR                                        000981
248   IF(FLOAT(I/4).NE.(FLOAT(I)/4.)) GO TO 250                         000982
      IF(FLOAT(J/4).NE.(FLOAT(J)/4.)) GO TO 250                         000983
      XX=XX+.04                                                         000984
      YY=YY+.04                                                         000985
      CALL NUMBER(XX,YY,.28,CNTR,0.,-1)                                 000986
250   CONTINUE                                                          000987
      RETURN                                                            000988
      END                                                               000989
C                                                                       000990
C*****************************************************************    000991
C                                                                       000992
      SUBROUTINE CELLIJ(I,NVC)                                          000993
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   000994
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           000995
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                         000996
C                                                                       000997
C       READ THE SHORELINE CODES                                        000998
      DO 100 K=1,5                                                      000999
      READ(2,101) IGRDNO,IST(K),IND(K)                                  001000
101   FORMAT(4X,I2,2I3)                                                 001001
      IEND=IST(K)                                                       001002
      JEND=IND(K)                                                       001003
      DO 102 J=1,JEND                                                   001004
      ENCODE(10,110,FMT)IEND                                            001005
110   FORMAT(1H(,I3,3HI1))                                              001006
102   READ(2,FMT) (IEDGE(II,J,K),II=1,IEND)                             001007
100   CONTINUE                                                          001008
      ENTRY CELL                                                        001009
C                                                                       001010
C       SET THE CODES FOR THE BOX TO BE CONSIDERED                      001011
      IEND=IST(IWNTGRD(I))-1                                            001012
      JEND=IND(IWNTGRD(I))-1                                            001013
      DO 103 J=1,IEND                                                   001014
      DO 103 K=1,JEND                                                   001015
      IB(1)=IEDGE(J,K,IWNTGRD(I))                                       001016
      IB(2)=IEDGE(J+1,K,IWNTGRD(I))                                     001017
      IB(3)=IEDGE(J+1,K+1,IWNTGRD(I))                                   001018
      IB(4)=IEDGE(J,K+1,IWNTGRD(I))                                     001019
C                                                                       001020
C       CHECK IF 2 OR MORE IB EQUAL 4. IF SO PROCEED                    001021
C         TO THE NEXT CELL                                              001022
      DO 104 JK=2,4                                                     001023
104   IF((IB(1)+IB(JK)).EQ.8) GO TO 103                                 001024
      DO 105 JK=3,4                                                     001025
105   IF((IB(2)+IB(JK)).EQ.8) GO TO 103                                 001026
      IF((IB(3)+IB(4)).EQ.8) GO TO 103                                  001027
      DO 106 KK=1,NVC                                                   001028
      CNTR=CONTOUR(KK)                                                  001029
      CALL TRACK(CNTR,J,K,JEND,I)                                       001030
106   CONTINUE                                                          001031
103   CONTINUE                                                          001032
      RETURN                                                            001033
      END                                                               001034
C                                                                       001035
C*****************************************************************    001036
C                                                                       001037
      SUBROUTINE ROTATE(XX,YY,X,Y,KGRD)                                 001038
      COMMON XUP,YUP,IGRD(3,150,5),NPTS(5),IWNTGRD(5)                   001039
      COMMON Z(29,65),IB(4),CONTOUR(30),SCALE                           001040
      COMMON IST(5),IND(5),IEDGE(29,65,5),IFLAG                         001041
      ROOT2=SQRT(2.)                                                    001042
      X1=-YY                                                            001043
      Y1=-XX                                                            001044
      X2=-Y                                                             001045
      Y2=-X                                                             001046
      IF(IWNTGRD(KGRD).NE.1) GO TO 1                                    001047
      XX=X1/ROOT2+Y1/ROOT2                                              001048
      YY=Y1/ROOT2-X1/ROOT2                                              001049
      X=X2/ROOT2+Y2/ROOT2                                               001050
      Y=Y2/ROOT2-X2/ROOT2                                               001051
      GO TO 2                                                           001052
1     XX=X1                                                             001053
      YY=Y1                                                             001054
      X=X2                                                              001055
      Y=Y2                                                              001056
2     CONTINUE                                                          001057
      RETURN                                                            001058
      END                                                               001059
```

```
ILVBK,CM130000,T120,MT2,P2.  BOB KEELEY                                          000001
ACCOUNT,*****.                                                                   000002
ATTACH,A,BKFEA,ID=MEDS.                                                          000003
ATTACH,TAPE11,DGFUNDY1E,ID=MEDS.                                                 000004
LABEL,TAPE15,R,L=DGDXR11,T=999,X=SV.ER0143                                       000005
FTN,I=A,OPT=2,L=0.                                                               000006
LGO.                                                                             000007
RETURN,A,TAPE11,TAPE15,LGO.                                                      000008
ATTACH,A,BKBFAPHASEX,ID=MEDS.                                                    000009
ATTACH,TAPE1,BRBFGRIDX,ID=MEDS.                                                  000010
ATTACH,TAPE2,BKAPEDGE,ID=MEDS.                                                   000011
ATTACH,LIB,MEDSPLIB,ID=MEDSPLIB,MR=1.                                            000012
LIBRARY(LIB)                                                                     000013
REQUEST,TAPE10,HY,S,SV,MT.MOUNT OCEANPLOT TAPE RETURN KEELEY STOP1               000014
FTN,I=A,L=0.                                                                     000015
LGO.                                                                             000016
    1   48    1   30 1440                                                        000018
1.00543210.25                                                                    000020
   30                                                                            000021
  20.00  40.00  60.00  80.00 100.00 120.00                                       000022
 140.00 160.00 180.00 200.00 220.00 240.00                                       000023
 260.00 280.00 300.00 320.00 340.00 360.00                                       000024
 380.00 400.00 420.00 440.00 460.00 480.00                                       000025
 500.00 520.00 540.00 560.00 580.00 600.00                                       000026
   14                                                                            000027
  10.00  20.00  30.00 239.90 260.00 280.00                                       000028
 300.00 320.00 330.00 340.00 350.00 360.00                                       000029
 370.00 380.00                                                                   000030
RUN EX40                                                                         000031
```

APPENDIX F: The Phase Discontinuity Problems

The discontinuity in the value of the phase (i.e. the equivalence of 0° and 360°) can cause difficulties in contouring phase values. This arises, for example, when the 4 corners of a grid unit have phases of 4°, 355°, 357°3° respectively clockwise. In this case, although only the contour values of 359° and 1 may be desired to be contoured through this unit, nearly all other contour values also lie between these values. The solution for such a case was to compare pairs of phase values at adjacent corners and where they differed by more than 180°, 360° was added to the smaller phase. In this way the above mentioned values become 364°, 355°, 357° and 363°. In order to have the 1° contour drawn in this unit it is necessary to specify 361 as a value to be contoured as well as 1°.